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Other Things Are Never Equal

Explicitly or implicitly, attached to each law of empirical science is a clause that reads: "other things being equal." For example, one says, or at least means, "all bodies fall with a constant acceleration, other things being equal," or "water always puts out fire, other things being equal." This clause allows for the fact that a law is not necessarily disproved by those instances in which the law fails to hold true, since it may be that other things are not equal. It is well known that bodies do not fall through the earth's atmosphere with a constant acceleration, and that water does not put out burning oil.

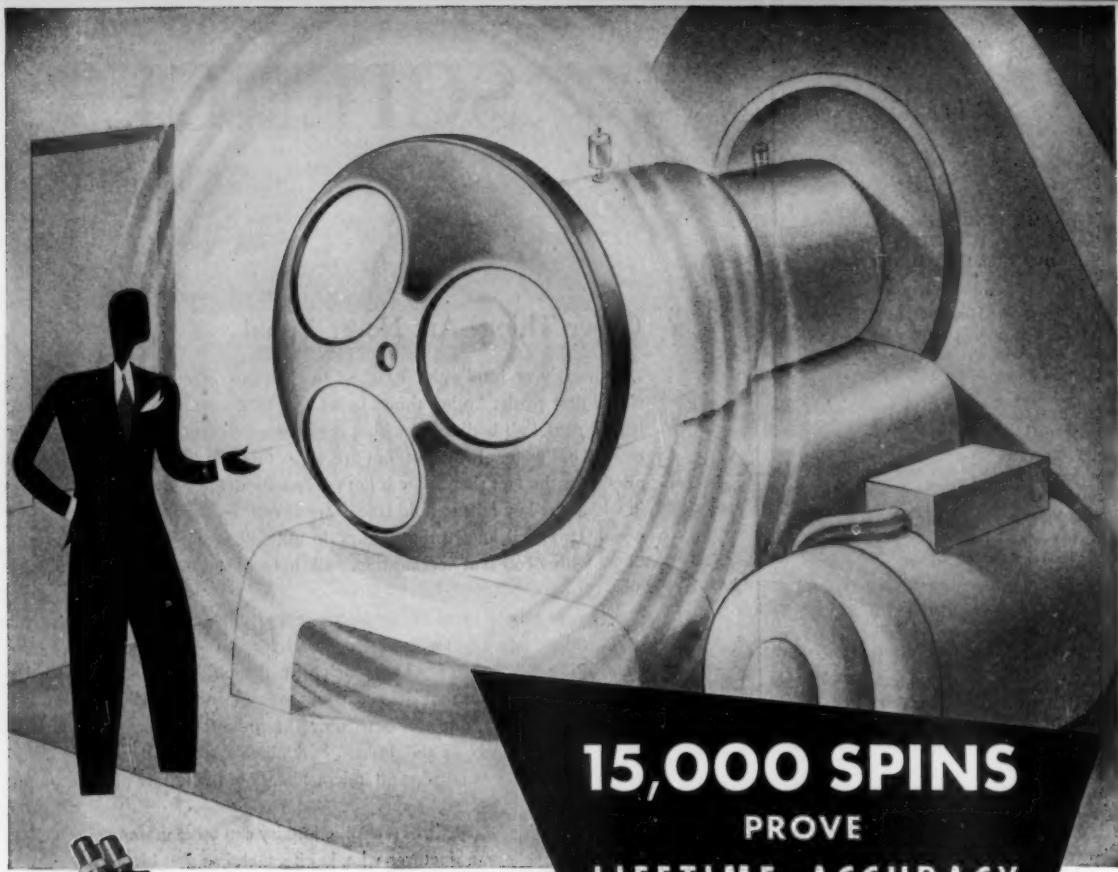
A simple requirement prevents this property of experimental laws from degenerating into a situation in which each law is found to hold true except when it is not found to hold true. Scientists demand evidence for the existence of the condition that defeats a law, other than the failure of the law itself. For example, one can determine the presence of the earth's atmosphere independently of the failure of Galileo's law and one can determine the presence of burning oil independently of the failure of water to put out fire.

Unfortunately, the logic of scientific inquiry can serve mammon as well as truth. Imagine a manufacturer who, in effect, claims that his product works only under certain special conditions. If upon investigation, the product fails to perform as promised, well, then, other things are not equal. By introducing a long list of difficult special conditions, the manufacturer can explain away his product's failure and make its successes difficult to reproduce. After all, when a series of experiments is run, the conditions are bound to change. If the investigator takes the precaution of wearing the same necktie throughout, that necktie will be a bit more frayed at the close of the series than it was at the start. As the well-grounded skeptic knows, other things are never exactly equal.

In a recent editorial [*Science* 123, 1059 (15 June 1956)], we reported some aspects of the Federal Trade Commission's hearing of the AD-X2 battery additive. In an article in the present issue (page 1107), we offer a more extended account of another case, the Evis Water Conditioner. Both developments illustrate in a small way this logic of other things that are never equal. We do not intend to devote our journal to the rulings of the Federal Trade Commission, but we should like to share our concern about their doings.

Something close to despair must engulf the scientist who watches the instruments of his calling, and his reluctance to claim certainty, turned against him.—J. T.





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Structure of Influenza Virus

F. Macfarlane Burnet

This discussion is concerned with the topic which for the last 10 years has been the main preoccupation of my laboratory, the structure of influenza virus. This grew out of a more limited attempt to understand the significance of hemagglutination by the virus and has been greatly influenced by our recent work on the genetic behavior of influenza viruses. Most of the new work that I have to report is due to my colleague, G. L. Ada, whose investigations on the nucleic acids of influenza virus have, I believe, provided a very valuable chemical basis for the functional understanding of influenza virus structure.

At the present time, viruses occupy a key position in relation to general biological thought. As the smallest agents showing the essential characters of organisms, they provide virtually the only hope that their structure may be simple enough for comprehension in terms of accepted physicochemical concepts. I have some unorthodox doubts about the applicability of such concepts, even in principle, to the interpretation and control of essential biological phenomena, and I should prefer to regard viruses as providing the best field for the development of the complementary concepts that will eventually be needed.

Virology in a sense brings to a focus on a single set of phenomena the disciplines of organic and physical chemistry, on the one hand, and of genetics and cytology, on the other. In the background

we have the humanly important implications of our subject for pathology and clinical medicine and for epidemiology and public health.

Influenza virus has its special human importance as potentially the greatest killer under modern conditions of all the pathogenic microorganisms. The 1918-19 pandemic set back the population growth of India by a decade. In the last analysis, an understanding of the structure of influenza virus must be incomplete if it does not provide, at least in principle, means by which pandemic influenza can be forecast and prevented. It is possible, however, to forget completely the medical importance of influenza and to study the virus in its interaction with the susceptible cells of the chick embryo, simply as a controllable laboratory phenomenon to be elucidated. This is the approach that has provided the data and ideas with which I am concerned in this article.

The general character of laboratory work in influenza virus is well known. For the time being, the chick embryo has not yet given place to tissue culture as the standard method for cultivation of the virus. A particle of influenza virus is recognized and in a sense defined by the fact that when it is introduced into the allantoic cavity of the chick embryo, a continuing sequence of infections of the lining cells is initiated which results finally in the liberation of very large amounts of descendant virus into the allantoic fluid. The presence of this virus is recognized in practice by the fact that the fluid has now acquired the capacity to agglutinate red cells. It might also be detected by examining suitable preparations of the fluid by electron microscopy.

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The virus may be present as spherical bodies about 100 millimicrons in diameter or in filaments of somewhat smaller diameter and of variable but sometimes relatively enormous length.

Quantitative Work

All quantitative work on influenza virus is based on the use and intercomparison of the following three methods.

1) The infectivity—that is, the number of functionally active units—is determined by inoculation of appropriate dilutions into large enough numbers of chick embryos or their equivalents. The fact of infection is recognized by the hemagglutinating activity of the fluid.

2) The content of virus particles with functional surface qualities, irrespective of whether they are infective or not, can be estimated by suitable quantitative methods for estimating hemagglutinating power.

3) The content of morphologically typical particles can be estimated by electron microscopic methods. The presence and approximate number of filaments can be established by simple dark-field microscopy.

The application of such methods by Hirst, the Henles, Fazekas, Horsfall, and others (1) has shown the sequence of events in a susceptible cell. This sequence can be summarily stated as follows.

1) The virus particle attaches itself to the free surface of the cell, the union being mediated by an attachment of an enzyme-like component of the virus surface to prosthetic groupings (recently defined by Gottschalk, 2) of cell-surface mucoprotein.

2) The virus particle enters the substance of the cell and rapidly loses its existence as an infective particle in the sense that an extract of that cell is no longer infective for a fresh embryo.

3) About 3 hours after infection, new virus is detectable in the cell; and from about 4 hours onward, new infective virus is being liberated from the cell. There is good evidence to suggest that the production of new infective virus takes place at the free surface of the cell.

It is clear that the problem of virus structure has a twofold character. On the one hand, we are concerned with the

structure of the infective virus particle as it can be isolated from a standard infected allantoic fluid. On the other hand, we have the processes taking place in the infected cell by which a new generation of infective particles is produced. We are concerned here with what is virtually a new functional organism, the virus-infected cell. There are even superficial resemblances between the process of fertilization of the mature ovum and of infection by virus of a susceptible cell. In each case, the cell is impelled to activities whose end result is determined or at least strongly influenced by the genetic character of the intruding agent. In each case, we are concerned basically with the interaction of two genetic systems in a single cell. It is possible to describe the infective virus particle as a relatively simple unit, but any description of the pseudo-organism, the infected cell, must necessarily be at least as complex as that of the cell itself.

Physical Structure and Chemical Composition

Most of the work has been done with the well-adapted standard strain of influenza virus A—PR8. In allantoic fluid virus, the particles are mainly spherical with only a few short filaments. The particles show an average diameter that varies according to the method used in preparing the specimen for electron micrography. With freeze-dried preparations, Williams (3) found that the average diameter is 82 millimicrons, and that in all preparations not subjected to sorting out processes, there is a considerable range of size. There is no clear indication of internal structure.

Although they are rare and inconspicuous in PR8 preparations, filaments are very characteristic of a number of recently isolated strains. In their most typical form, they appear in electron micrographs as uniform cylindrical objects approximately 70 millimicrons in diameter and of lengths which may be anything up to 20 or 30 microns. They very often show a "knob" of slightly greater diameter at one end of the filament.

In a later section, something will be said about the behavior of filaments, but here I wish merely to state the evidence for regarding them as "influenza virus." In the first place, they are well-defined morphological objects, which are seen only in fluids from embryos infected with the virus. They are readily adsorbed to red cells or red-cell ghosts and can be eluted either spontaneously or by the action of the receptor-destroying enzyme. Donald and Isaacs (4) found that a single filament has more activity as hemagglutinin than a single spherical particle

and that sonic disintegration sharply increased the hemagglutinin titer of a preparation containing a high proportion of filaments. The results of infectivity titrations were indecisive, but they were consistent with the view that each filament was equivalent to approximately one infective unit. Infectivity, however, seems to be neither increased nor decreased by manipulations that break down the filamentous structure.

The chemical composition of purified virus particles from allantoic fluid has been reported on by various authors. For the most part, the results obtained are very similar to the analyses of cytoplasm from animal cells. There is present in terms of dry weight the following. (i) Lipids, 20 to 30 percent, including neutral fat, phospholipid, and cholesterol. (ii) Carbohydrates, approximately 5 percent, much of which is probably associated with mucoprotein, for it includes galactose, mannose, fucose, and hexosamine; ribose is present as a component of nucleic acid. (iii) Nucleic acid, 1 percent \pm of ribose-nucleic acid only. (iv) Protein, 60 to 70 percent, the amino acid composition of which is close to that of animal protein generally.

There is much to suggest from these analyses that a considerable proportion of the material contained in what is conventionally regarded as purified virus particles is very directly derived from the host cell. Further evidence in this direction is given by Knight's well known finding of components with the immunological specificity of host tissue in washed influenza virus (5).

As in so many analogous situations, the identification of material as specifically viral depends on functional rather than analytic, chemical tests. Of the functional components of the particle, we can recognize two by serological methods usually referred to as viral antigen and soluble complement-fixing antigen and one, presumably carried by the same complex responsible for the viral antigen, by its specific adsorption to and/or enzymatic action on red cells or equivalent mucoprotein.

The relationship of these functional components to the morphological and chemical components has not been satisfactorily worked out for influenza virus. However, practically all the published findings, as well as current work by Ada (6), suggests that the situation is very similar to or identical with what has been found for fowl plague virus by Zillig and his collaborators (7). Using repeated ether treatment as a means of disrupting the virus particle, they found that a hemagglutinin unit considerably smaller than the virus could be obtained. This material has recently been reported as being composed of protein with, probably, some contaminating polysaccharide

but no nucleic acid. It is reasonable to believe that its specific attributes are based on the protein. The second functional component from disrupted fowl plague virus is the soluble complement-fixing antigen which can be shown in electron micrographs as small elongate granules. Ada has recently found that similar soluble complement-fixing antigen can be obtained from purified influenza virus similarly treated with ether. Since the complement-fixing activity is not shown by the intact particles, it must be assumed that the specific pattern involved is not at the virus surface.

It may be mentioned here that the action of ether on influenza virus is apparently greatly modified by minor environmental circumstances. With freshly redistilled ether we have failed to confirm the statement that exposure of allantoic fluid virus to 20-percent ether at refrigerator temperature overnight destroys its infectivity. Prolonged and repeated treatment is necessary for disruption of infective particles.

Filamentous forms of recently isolated strains of influenza virus have in recent years been extensively studied at Mill Hill and in my own laboratory. We have made use of the fact that filaments can be seen and counted using simple dark-ground microscopy. This allows the quantitative study of agents capable of breaking down filaments. Our most interesting finding was that, with one partial exception, all the agents tested that were capable of hemolyzing fowl erythrocytes destroyed influenza virus filaments and that the end point for both types of lytic action was almost precisely the same. The test included such varied agents as hypotonic solutions, ether and chloroform, sodium lauryl sulfate and cetyltrimethylammonium bromide, *Clostridium welchii* α -lecithinase, cobra venom, and lysozyme. The exception, saponin, gave rise to distorted and beaded forms in dilutions corresponding to its hemolytic level, but the forms remained recognizable as filaments throughout. Disruption of filaments by ether or chloroform gave rise to a variable increase in hemagglutinin titer in fluids containing a high proportion of filaments but gave no change in infectivity. This parallels the finding of Donald and Isaacs with sonic disintegration.

Our conclusion is that influenza virus filaments may contain infectious units, probably in the knobs visible in electron micrographs, but as such they are noninfective. Their surface, however, includes virus specific antigen and enzyme. It resembles the surface of a red cell and by implication that of more typical avian cells in being very sensitive to disintegration by ether and other hemolytic agents. The spherical virus particle has been adequately identified with both the infective agent and the hemagglutinin. It is much

more stable than the filament, but its high content of lipid and the presence of mucoprotein suggest that it too has important affinities to the surface structure of vertebrate cells.

Mechanism of Fabrication

The relationship between spherical infective particle and virus filament can be understood clearly only in terms of the process by which the particle and filament are produced. This leads us to the consideration of the intracellular phase which I have already described as the interaction of two genetic systems to produce what is virtually a new organism—the infected cell.

This interpretation is based essentially on three experimental findings: (i) the disappearance of infectivity after infection is initiated, (ii) the occurrence of a variety of genetic interactions between virus types when appropriate double infections are induced, and (iii) the presence of host-specific components in the virus progeny.

Any detailed understanding of what is taking place must be built up in rather speculative fashion from disconnected fragments of information against the background of what is known about normal synthetic processes in the cell. The relevant information may be divided into four classifications: (i) that concerned with the behavior of ribose nucleic acid; (ii) the appearance and distribution of soluble complement-fixing antigen; (iii) the genetic evidence for the existence of a "replicating pool" of virus components; and (iv) evidence for the direct part played by the cell surface in assembling the virus.

Ada and Perry (8) have shown that the nucleic acid content of purified influenza virus is low— ± 1 percent—and that only ribose nucleic acid is present. This has been confirmed in other laboratories by Hirst (1), Hoyle (9), and Liu *et al.* (10). The nucleic acid bases adenine, guanine, cytosine, and uracil are present in a ratio which differs significantly as between A and B strains and is sharply distinct from that of ribose nucleic acid isolated from normal allantoic membrane cells. Ada therefore believes that the pattern of bases in ribose nucleic acid isolated under various circumstances associated with influenza virus infection may throw important light on the processes involved. This is, of course, in line with the insistent evidence from various sources that synthesis of protein in the cell cytoplasm is intimately associated with ribose nucleic acid activity.

Ada's other findings may be summarized as showing (i) that soluble complement-fixing antigen extractable from infected embryo lung contains ribose nu-

cleic acid that has a base constitution close to that from a similar fraction of normal cells; (ii) that virus produced in chick embryo lung and purified by standard processes has a similar content of ribose nucleic acid, but its base constitution deviates from that of allantoic virus toward the host cytoplasm pattern; (iii) that soluble complement-fixing antigen extracted from allantoic fluid virus has the characteristic base composition of virus ribose nucleic acid.

Interpretation of such results may have to wait on the better understanding of normal protein synthesis, but one point is clear. The mechanism by which virus patterns are conveyed to descendant virus requires ribose nucleic acid only—it is a genetic system in which desoxyribose nucleic acid is not directly involved.

The concept of a pool of replicating components is well established in the literature of bacterial viruses and is clearly also applicable to the cell infected with influenza virus. The genetic evidence is decisive on this point. Recombination of characters requires interpenetration of genetic material from the two parent forms. The existence of phenotypic mixtures—doubly neutralized hemagglutinin—in which the virus carries a mosaic of surface patterns shows further that not only the genetic but also the somatic components are extracted from a common pool of components. The appearance early in the process of soluble complement-fixing antigen with viral specificity offers a hint that this is an important component of the replicating pool.

In rather general terms, we can picture the replicating pool as being built up by the partial or complete taking over of a protein- and ribose nucleic acid-synthetic mechanism by virus components of which the most important may be the specific ribose nucleic acid of the virus particle. This results in the production, presumably by processes of direct or indirect replication, of (i) those host components needed for the metabolic support of the replicating process, (ii) genetic components of the virus, and (iii) somatic virus components of which the only demonstrable example is the surface component which appears to be responsible for hemagglutinin enzyme and viral antigen.

All the evidence obtainable from studies of allantoic multiplication of influenza virus and the related fowl plague virus points to the cell surface as the site of fabrication of the virus particles and filaments. Cairns and Mason by comparing the rise of virus titer in allantoic membrane extracts with that free in the allantoic fluid, both with and without treatment with receptor-destroying enzyme, concluded that detectable virus came into existence virtually at the same time that it was liberated from receptor-destroying-enzyme-treated cells (11). It

was as if, by passing through the host cell membrane, it acquired specific character.

Electron micrographs of sections of infected allantoic cells show recognizable virus only at the free surface. In the pictures of fowl plague virus published by Hotz and Schafer (12), the particles seem to be budding off the cell surface. All workers agree that filaments form as extrusions from the cell surface, the shorter examples of which are difficult to distinguish from the microvilli to be seen at the free surface of uninfected cells. Harford's (1955) pictures of the process in the epithelial cells of the mouse lung show what appears to be an accumulation of virus particles in cytoplasmic inclusions, as well as distortions of the endoplasmic reticulum (13). The published figures do not seem to be inconsistent with the view that the virus particles are formed at a surface between the fluid of a vacuole and the cell substance, but the conditions are clearly not very closely analogous to those in the allantoic cells. Cells from infections of chick embryo lungs are typically vacuolated and in an early paper of mine it was suggested that these vacuoles might contain virus (14).

Although it is not relevant to the final stage of fabrication of virus particles, it should not be forgotten that there is evidence of nuclear involvement in the early stages of infection, and gross nuclear damage is a characteristic feature of a proportion of necrotic cells.

Out of this discussion there emerges a fairly clear though perhaps rather superficial interpretation of the structure of the influenza virus particle and the mechanism by which it is fabricated.

Penetration of Cell

Omitting for the time being any discussion of the filaments, we can commence with the penetration of a virus particle into the cell and the liberation in the cell substance of the essential genetic components of the virus. On the basis of Ada's findings, it is legitimate to consider these as being wholly or in part composed of ribose nucleic acid, and as making intimate association with ribose nucleic acid- and protein-synthetic mechanisms in the cell. This interaction may begin with some sort of "tooling-up" of templates in the nucleus, but the main production of new virus components must be in the cytoplasm. One pictures first a mobilization of synthetic activity represented histologically by enlargement of the nucleolus and intense pyronin staining of the cytoplasm, particularly in the perinuclear region. If Ada's results can be taken at their face value, two types of ribose nucleic acid may both be associated with serologically recognizable viral patterns that are characteristic of

cell extracts having the host cell distribution of bases while a virus-specific distribution is shown in what is finally incorporated in the infective particle. The replication of genetic material and the concomitant production of somatic units (assuming that these are distinct from the genome) result eventually in a high concentration of viral material of all types in the superficial cytoplasm of the allantoic cell.

The fabrication of the virus particle is best pictured as a process by which somatic units (of the virus) infiltrate the surface membrane of the cell to build up a stable membrane containing lipid and mucoprotein of host origin as well as the viral protein. This membrane finds its maximal stability when it is enclosing a sphere of about 100 millimicrons in diameter, and the simplest possible assumption is that in forming such a sphere the corresponding volume of cytoplasm with its contained components of the replicating pool is trapped inside.

It would be very much in accord with such a view for incompletely adapted virus strains to induce quite frequently a minor deviation of the process of space enclosure by a developing cell surface-virus protein membrane so that, instead of a spherical bud, an indefinitely extruding cylinder is produced. This would be an appropriate interpretation of filament formation. There is some evidence that filaments have fewer points of attachment to red cell receptors than spherical forms, and the filament surface would therefore be less altered from the host cell surface than that of the spherical particle. Its similar reaction to lytic agents would thus be understandable.

We reach, then, a picture of the standard virus particle as a rather loosely organized unit containing two types of macromolecule whose specific pattern is determined by the genetic character of the parent virus or viruses. On the surface, there is imbedded in a stable mosaic with lipid and mucoprotein components of cell origin a number of macromolecular units which carry, presumably on a protein basis, the specific patterns responsible for enzyme activity and adsorption to cell mucoprotein and for serological character of the viral antigen type. These patterns are characteristic of the

virus strain and are genetically determined. We believe that they should be regarded as somatic in character and that from the point of view of survival of the virus their character determines the readiness with which infection can pass from one susceptible cell to another and initiate infection.

Within the particle, there is a variable number of genetic units, probably ribose nucleic acid-protein complexes. From genetic studies it is believed that these complexes in influenza A strains may show qualitative differences of types broadly similar to what is postulated for chromosomal behavior in higher forms. Lind and I have postulated two "linkage groups," each containing a number of loci subject to mutation. There is some evidence that the division into two linkage groups merely indicates that a single genetic complex breaks most readily at a certain point. The viable particle contains a number, which we have guessed as between five and 50, of such genetic complexes. It is entirely in accord with the findings in regard to incomplete virus and the phenomena of recombination, especially in the field which we have referred to as redistribution of virulence, that the genetic content of individual virus particles should vary in random fashion from one individual particle to another.

Conclusion

I should like to summarize our concept of the influenza virus particle as follows.

The virus particle is a loosely organized unit in which a surface membrane, which is derived largely from the host cell but which owes its specific qualities to a regular reinforcement with virus protein, encloses a variable number of genetic determinants which are almost certainly of ribose nucleic acid-protein structure and a proportion of adventitious material from the host cytoplasm.

It is not a rigidly organized structure like a bacterial virus or one of the smaller viruses such as poliomyelitis or tobacco mosaic virus. It would be in line with the present concept to look on polio virus as an organized aggregate of genetic determinants of standard size instead of, as

it were, a bag containing a loose collection of genetic units.

There may well be some prejudice against accepting such a simple and somewhat indeterminate structure for influenza virus. However, to anyone who has worked extensively with influenza virus it is unthinkable that we are dealing with a highly standardized unit. In particular, we can mention (i) the variable diameter of spheres and the alternate filamentous morphology; (ii) the existence of varying degrees of incompleteness with evidence of morphological and chemical variation in relation to this; (iii) the existence of phenotypic mixtures in the progeny of mixed infections; and (iv) the redistribution of virulence when certain pairs of virulent and avirulent strains produce recombinants.

I have made no attempt in this paper to elaborate any of the genetic evidence on the basis of which this concept was first developed. This has been given in full elsewhere (15).

What remains to be done is to penetrate more deeply into the nature of the genetic determinants. Here I think we can look for developments from the correlation of ribose nucleic acid base analyses with genetic studies, and I am very hopeful that the current interest in the structure of polio virus will eventually allow a similar combined chemical and genetic attack on one of the smaller macromolecular viruses.

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A mathematical investigation always obeys the law of the conservation of knowledge; we never get out more from it than we put in. The knowledge may be changed in form, it may be clearer and more exactly stated, but the total amount of the knowledge of nature given out by the investigation is the same as we started with.—HENRY A. ROWLAND.

Spectrophotometric Studies of Oxidative Phosphorylation

Maynard E. Pullman and Efraim Racker

The mechanism by which mitochondria form adenosine triphosphate (ATP) (1) from adenosine diphosphate (ADP) and inorganic phosphate concomitant with the oxidation of carbohydrates, fatty acids, and some amino acids has been the subject of much intense investigation. The chief difficulties which have limited the experimental approach have been the lability of the phosphorylating system and the lack of a convenient, direct, and rapid method for the study of the kinetics of the phosphorylation process.

Some success in stabilization of the phosphorylating enzymes has been achieved by the use of ethylenediamine tetraacetic acid (EDTA) (2) and serum albumin (3). It has been suggested that the latter exerts its stabilizing effect by maintaining the structural integrity of the mitochondria (4). Until very recently, the phosphorylation processes were believed to be to a large extent dependent on the high degree of morphological organization inherent in the mitochondria, and the disruption of this organization was paralleled by an uncoupling of phosphorylation from electron-transfer processes. However, recent demonstrations of the occurrence of oxidative phosphorylation in extracts of bacteria (5) and of animal tissue mitochondria (6) have given impetus to the study of the enzyme components of the system.

A systematic study (7) of coupled phosphorylation has been initiated in this laboratory with the aims of (i) developing a spectrophotometric assay for the direct and continuous measurement of phosphorylation, (ii) investigating the factors responsible for the extreme lability of oxidative phosphorylation in intact mitochondria, and (iii) obtaining stable extracts of mitochondria capable of carrying out oxidative phosphorylation.

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Spectrophotometric Assay

Mouse liver mitochondria were prepared in 0.25M sucrose containing 0.005M ethylenediamine tetraacetic acid according to a modification of the method of Schneider (8) similar to that used by Kielley and Kielley (9). Preliminary experiments demonstrated that these mitochondrial preparations were virtually unable to oxidize either reduced triphosphopyridine nucleotide (TPNH) or reduced diphosphopyridine nucleotide (DPNH) under the experimental conditions used in this study to measure oxidative phosphorylation. However, diphosphopyridine nucleotide (DPN) reduced inside the mitochondria by a diphosphopyridine nucleotide-linked substrate, such as β -hydroxybutyrate, is readily oxidized (10).

During this process, up to 3 moles of adenosine triphosphate are formed from adenosine diphosphate and inorganic phosphate per mole of reduced diphosphopyridine nucleotide that is oxidized (11). Since the adenosine triphosphate formed is available for the phosphorylation of glucose by externally added hexokinase, it was possible—by supplementing the mitochondria with adenosine diphosphate, inorganic phosphate, magnesium ion (Mg^{++}), β -hydroxybutyrate, glucose, hexokinase, glucose-6-phosphate (G-6-P) dehydrogenase, and triphosphopyridine nucleotide (TPN)—to follow the continuous formation of adenosine triphosphate in a Beckman spectrophotometer, which was equipped with a photomultiplier tube, by measuring the reduction of triphosphopyridine nucleotide at a wavelength of 340 millimicrons. The sequence of the reactions of the test

system is shown at the bottom of this page.

This assay differs in principle from the ingenious methods described by Chance and Williams (12) in which oxidative phosphorylation is measured indirectly by rates of respiration and which, in addition, require special apparatus.

Since β -hydroxybutyrate is oxidized to acetooacetate (AcAc), which is not further metabolized in liver mitochondria, it is possible to calculate P/O ratios from acetooacetate and inorganic phosphate measurements (13, 13a). The physical state, and hence the light-transmitting and -scattering properties of the mitochondria, are affected by some of the constituents of the reaction mixture (14). It is therefore essential that every experimental variation of the constituents be controlled by a check cell containing all ingredients except triphosphopyridine nucleotide. Each spectrophotometric reading is taken against this control cell in check position. In the experimental values reported, a small correction has been applied for the action of mitochondrial adenylic kinase on adenosine diphosphate, which results in the formation of adenosine triphosphate and the reduction of triphosphopyridine nucleotide in the absence of inorganic phosphate or in the presence of 2,4-dinitrophenol (DNP). In order to diminish this correction factor, adenosine diphosphate was used at suboptimal concentration.

In Table 1 (column 1), it may be seen that the formation of reduced triphosphopyridine nucleotide is dependent on the presence of inorganic phosphate, adenosine diphosphate, hexokinase, and glucose-6-phosphate dehydrogenase, and partially dependent on β -hydroxybutyrate and magnesium ion. Addition of diphosphopyridine nucleotide had little or no effect. Phosphorylation is completely inhibited by $5 \times 10^{-5} M$ 2,4-dinitrophenol. The pronounced dependency on β -hydroxybutyrate that is recorded in Table 1 with aged preparations (column 2) is not usually observed with fresh mitochondria (column 1).

Restoration of Phosphorylating Activity in Aged Mitochondria

The addition of serum albumin to preparations of insect sarcosomes (3) or rat liver mitochondria (15) has been shown to maintain the phosphorylation

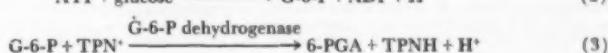
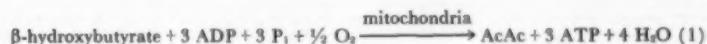


Table 1. Spectrophotometric assay of oxidative phosphorylation in fresh and aged liver mitochondria* (16a).

Addition	Change in optical density in 10 min at 340 m μ $\times 10^3$	
	Fresh preparation	Aged preparation
None	1357	87†
Bovine serum albumin (2000 μ g)	1483	872
Bovine serum albumin (500 μ g)	1327	814
+ Diphosphopyridine nucleotide	1405	98‡
+ 2,4-Dinitrophenol (5×10^{-6} M)	35	0‡
+ 2,4-Dinitrophenol (2×10^{-6} M)	381	534‡
- β -Hydroxybutyrate	602	56‡
- Orthophosphate	228	91‡
- Adenosine diphosphate	64	0‡
- Hexokinase	2	0‡
- Glucose-6-phosphate dehydrogenase	308	
- Magnesium ion (Mg ⁺⁺)	992	

* The complete system (1.0 ml) contained the following: 0.1M tris(hydroxymethyl)aminomethane at pH 7.4; 0.005M glucose; 1.4×10^{-6} M adenosine diphosphate; 0.001M triphosphopyridine nucleotide; 3×10^{-4} M MgCl₂; 0.01M orthophosphate at pH 7.4; 0.012M DL- β -hydroxybutyrate; 50 units of hexokinase (17); and 0.3 units of glucose-6-phosphate dehydrogenase (18). The reaction was started by the addition of mitochondria obtained from 20 mg (wet wt.) of mouse liver in a mixture of 0.25M sucrose and 0.005M ethylenediamine tetraacetic acid (480 μ g of protein in column 1, 409 μ g of protein in column 2) to a microcuvette with a 1-cm light path. The optical density changes at 340 m μ were recorded for 10 minutes against a control cell identical with the experimental cell except that triphosphopyridine nucleotide was omitted. Protein was determined according to Robinson and Hogden (19).

† The activity obtained with this preparation before aging was 1340.

‡ In these experiments, 500 μ g of bovine serum albumin were present in addition to the indicated protocol.

Table 2. Correlation of spectrophotometric assay of phosphorylation with orthophosphate uptake and acetoacetate formation in an aged mitochondrial preparation.*

Additions	Glucose-6-phosphate (μ mole)	Orthophosphate uptake (μ mole)	Acetoacetate formed (μ mole)
None	0.01	-0.10	0
β -Hydroxybutyrate	0.07	-0.02	0.43
Bovine serum albumin	0.10	0.17	0
β -Hydroxybutyrate + bovine serum albumin	0.56	0.62	0.36

* The complete system (3.0 ml) contained the following: 0.1M tris(hydroxymethyl)aminomethane at pH 7.4; 0.005M glucose; 1.4×10^{-6} M adenosine diphosphate; 0.001M triphosphopyridine nucleotide; 3×10^{-4} M MgCl₂; 0.001M orthophosphate at pH 7.4; 150 units of hexokinase; and 0.9 units of glucose-6-phosphate dehydrogenase. To this test system was added 0.012M DL- β -hydroxybutyrate and 500 μ g of bovine serum albumin, as indicated. The reaction was started by the addition of aged (24 hours) mitochondria from 60 mg of mouse liver in a mixture of 0.25M sucrose and -0.005M Versene (1.44 mg protein); readings were recorded for 20 minutes. The reaction was stopped by the addition of 0.3 ml of 50-percent perchloric acid. After centrifugation, aliquots of the supernatant were taken for orthophosphate analysis (20) and acetoacetate determination (21).

Table 3. Uncoupling of oxidative phosphorylation by mitochondrial factor and effect of bovine serum albumin.*

Additions	Glucose-6-phosphate		Orthophosphate uptake (μ mole)	Acetoacetate formed (μ mole)
	Direct (μ mole)	Indirect (μ mole)		
None	0.38	0.35	0.18	0.78
Bovine serum albumin	0.68	0.61	0.66	0.62
Inhibitor	0.09	0.06	0	0.65
Bovine serum albumin + inhibitor	0.70	0.62	0.78	0.78

* The complete system (3.0 ml) was the same as that described in Table 2, including 0.012M DL- β -hydroxybutyrate. To this system were added 1500 μ g of bovine serum albumin and 0.3 ml of an aqueous suspension of mitochondrial factor (see text) as indicated. The reaction was started by the addition of 0.03 ml of freshly prepared mitochondrial suspension containing 1.14 mg of protein; the reaction was followed for 20 minutes. The total change in optical density for the 20-minute period is recorded in Table 3 as the direct assay of glucose-6-phosphate. The reaction was stopped by the addition of 0.3 ml of 50-percent perchloric acid to both the experimental and the check cells. After centrifugation, the supernatant solution of the check cell was neutralized with 10N KOH, and an aliquot was assayed spectrophotometrically for glucose-6-phosphate with triphosphopyridine nucleotide and glucose-6-phosphate dehydrogenase (18). These values are recorded as the indirect assay of glucose-6-phosphate in Table 3. The experimental cells in each case were used for the determination of orthophosphate and acetoacetate as described in Table 2.

system, presumably by preserving the structural integrity of the mitochondria (4). We have confirmed the protective action of serum albumin. Moreover, we have found that it is possible to restore phosphorylation activity, in preparations which were completely inactivated by aging at 4°C for several days, by the addition of bovine serum albumin. The degree of restoration after 24 hours has varied from 50 to 100 percent in the different mitochondrial preparations. In Table 1, column 2, it can be seen that after 24 hours of storage at 4°C, approximately 65 percent of the original activity was restored upon the addition of 500 micrograms of bovine serum albumin. After 48 hours, this particular preparation was reactivated to approximately 40 percent of its original activity by 500 micrograms of bovine serum albumin. The response of fresh preparations to serum albumin has been variable. Some preparations show no effect, while others are stimulated some twofold.

That effects of serum albumin as measured by the increases of absorption at 340 millimicrons were in fact measurements of coupled phosphorylation and not unrelated optical changes is shown in Table 2. It can be seen that in the case of active phosphorylation there is reasonably good agreement between the spectrophotometric assay and determinations of inorganic phosphate disappearance. In experiments of this type, where both spectrophotometric and chemical measurements are required, the reaction was run in 3-milliliter Beckman cells with only 10 percent of the usual concentration of phosphate (1 micromole per milliliter). The use of this smaller amount of phosphate was necessary in order to measure phosphate disappearance with some degree of accuracy, even though it diminished the rate of the reaction to about half. Since suboptimal concentrations of inorganic phosphate and adenosine diphosphate were used, it is not surprising that low P/O ratios were obtained in some experiments. As can be seen from Table 2, serum albumin activates the phosphorylation process without essentially affecting the oxidation of β -hydroxybutyrate to acetoacetate. Concerning the specificity of serum albumin in "recoupling" phosphorylation to oxidation, several other proteins were tested. Gelatin, casein, insulin, and bovine γ -globulin were inactive, while β -lactoglobulin on a molar basis has approximately 20 percent of the activity of serum albumin.

In the light of these experiments, it appeared unlikely that serum albumin acted only by preserving the structural integrity of the mitochondria; hence, a search for another mechanism was made. A possible explanation for the serum al-

bumin effect is that it combined with an uncoupler of oxidative phosphorylation which becomes manifest on aging of the mitochondria.

Release of an Uncoupler

When mitochondria prepared in the usual manner were diluted in distilled water, a substance was released that, upon addition to fresh mitochondria, produced an inhibition of aerobic phosphorylation. As in the case of aged preparations, the inhibition could be reversed by the addition of bovine serum albumin. The inhibitor was prepared as follows: freshly prepared mitochondria from 15 grams of liver were diluted with 450 milliliters of water (to give a final protein concentration of 0.1 to 0.15 percent) and kept at room temperature for 1 hour. The extract was centrifuged at 18,000g for 20 minutes, and the residue was discarded. The inhibitory factor was concentrated either by lyophilization or by sedimentation at 144,000g for 1 hour in a Spinco preparative ultracentrifuge and then suspended in water. As shown in Table 3, the factor specifically inhibits phosphorylation without affecting the oxidation of β -hydroxybutyrate and thus simulates the action of 2,4-dinitrophenol and other known uncouplers. The addition of serum albumin to this system counteracts the effect of the inhibitor.

During the course of this work, our attention was drawn to the studies of Polis and Shmukler, who reported their findings at the meetings of the American Chemical Society (16). These authors have isolated from liver mitochondria an electrophoretically homogeneous heme protein which inhibits aerobic phosphorylation and which is counteracted by serum albumin. They suggest that this factor participates in the process of phosphorylation as an acceptor of energy-rich phosphate.

In view of these results, it appears likely that the generally recognized lability of aerobic phosphorylation in mitochondria may be partly explained on the basis of the release of this inhibitor.

References and Notes

1. The following abbreviations are used in this article: AcAc, acetacetate; ADP and ATP, adenosine di- and triphosphate, respectively; DPN and TPN, di- and triphosphopyridine nucleotide, respectively; DPNH and TPNH, reduced DPN and TPN, respectively; EDTA, ethylenediamine tetraacetic acid (Versene); G-6-P, glucose-6-phosphate; P_i , orthophosphate; 6-PGA, 6-phosphogluconic acid.
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tems for the purpose of beneficially treating and conditioning water."

The task for the Government in pressing its charges of false advertising was made difficult by the fact that the respondents averred that treatment with the "conditioner" did not affect the chemical or physical properties of the water in any detectable way but only the behavior of the water in use.

Burden of Proof

The company further claimed that both castings were processed by a secret method in such a way that they differ from ordinary cast iron and bronze. Metallurgical and spectroscopic examination of the iron castings (the bronze castings were not examined) failed to show that they differed from ordinary cast iron, but the hearing examiner ruled the evidence inconclusive when a metallurgist admitted that certain minute areas in the etched surface could not be identified and the spectroscopist admitted that the presence or absence of some 26 elements

Evis Water Conditioner

Graham DuShane

We feel obliged to let our readers share our interest in some of the highlights of a recent case before the Federal Trade Commission. It is in many ways parallel to that of the battery additive case [Science 123, 1059 (15 June 1956) and page 1099 in this issue].

On 5 Feb. 1954, the Federal Trade Commission issued a complaint against the Evis Manufacturing Company of San Francisco, Calif. The company manufactures a product, the Evis Water Condi-

tioner, which looks like an expanded pipe coupling with a vertical post integrally cast in the center of the internal chamber. The "conditioners" range in size from those that may be fitted into a 0.5-inch pipe to models that are intended to be fitted into large industrial or marine pipes and in price from \$25 for the smallest model to \$3700 for the largest bronze model. All models are made of either zinc-coated cast iron or bronze, and they are "intended to be fitted into water sys-

could not be detected by spectroscopic examination. The elements that could be detected appeared to be those of ordinary cast iron.

In a similar way, when a physical chemist, James I. Hoffman of the National Bureau of Standards, testified that there was no known way in which the castings could exert their effect and that such action would be contrary to the second law of thermodynamics, he was forced to admit that our scientific knowledge is still incomplete. Quotation from the hearings will serve to amplify this point:

"Q. Doctor, those are various types of energy that might be existing in any given water system and if you imposed upon that system some influence, either by the water coming into contact with the interface with metal or by some other means, would not that inherent energy in the system, at least, would there not be a scientific possibility that in converting that inherent energy in one of those forms into energy in some other form that you could bring about a change in the physical characteristics of the body of water without violating this first fundamental law of thermodynamics?

"A. It would be beyond my comprehension, if it could be done.

"Q. Well, that is based upon the knowledge that you have today, is it not, Doctor?

"A. Yes, sir.

"Q. And again I assume I would be correct in saying that as a scientist you would not foreclose the possibility that at some future date that could be established?

"A. All right."

The hearing examiner commented, in part: ". . . we must conclude that Dr. Hoffman's testimony as a whole, like that of other witnesses previously considered in relation to this issue, fails to establish that the Evis Water Conditioner does not have a catalytic or other effect upon water passing through it so as to change the physical behavior of such water in a beneficial way." It is logically impossible to prove a negative.

Perhaps something further should be said about the claimed catalytic effect. The respondent claimed that "his device resembles a catalyst because the results accomplished, like those of a catalyst, are accomplished by mere physical contact, and because the device, also like a catalyst, remains unchanged after the reaction has taken place. He recognizes

that it differs from a true catalyst in that the change accomplished is not chemical in nature." Hoffman's testimony on this point is of interest:

"Q. We have been told by the inventor of this unit that the action of it is closely related to catalysis, though it is not a true catalyst, because there is no attendant chemical change, but only the physical effect of the catalyst is involved. Is that theory scientifically sound, so far as you are concerned, Doctor?

"A. It is not.

"Q. Can you explain it?

"A. A catalyst can only change the rate of a reaction. It cannot make a reaction go that would not go otherwise.

"Q. You say that it would change the rate of the reaction. Is that a physical or chemical reaction?

"A. That is a chemical reaction."

And, later on, we have an exchange between Hoffman and his interrogator in which Hoffman replied to a question about whether water that had passed through the "conditioner" would be changed physically and, if so, ". . . would that effect persist after the water had gone beyond the Evis unit?" Hoffman replied:

"It could not . . . if it did it would violate one of the fundamental laws of thermodynamics."

The Government contended "That the Evis Water Conditioner will not cause dishes or glassware to dry without leaving water stains." One of the tests bearing on this point shows the technique in operation. Eight identical glasses were washed in a solution of warm water and soap. Four were rinsed in "treated" water and four in untreated water. After they were dried, two people examined the glasses. For the dirtiest ones, they picked two of the controls and two rinsed in "treated" water; for the cleanest glasses, they again picked two of the controls and two rinsed in "treated" water.

Of this experiment the examiner had this to say: "It appears that the tests . . . as to water stains prove nothing, because the negative and positive thereof were exactly equal. Accordingly we must conclude that the testimony offered in support of the allegation that the Evis Water Conditioner will not cause dishes or glassware to dry without leaving water stains has too little probative value to be regarded as substantial proof."

It was, of course, up to the Government to prove that the claims were false. But a scientist would turn the proposition

around and say, with the support of logic and several hundred years of experience of the experimental method to back him up, that this test failed to show that there was any significant difference in "treated" and untreated water, but this was not the question at issue.

Making Proof Difficult

The company further claimed that the mode of installation is important. The "conditioner" should be grounded; pipes carrying "treated" water should not be located near pipes carrying untreated water; "treated" water would lose its special virtues if mixed with untreated water. If any of these conditions were ignored, the respondents claimed that the device could not be expected to work. Furthermore, they did not claim the conditioner would be effective with all water but only with "some water." This last claim, if accepted, as it was by the hearing examiner, clearly precludes any significant testing of the device. One might be using the wrong kind of water.

One of the reasons that the examiner gave for ruling evidence of rinsing tests inconclusive appears in his statement that the tests were ". . . laboratory tests rather than practical tests." In short, we suppose what this means is that laboratory tests on scale formation, rinsing, scum formation, soap use, and so on, are not held to be relevant to the question of the merit of a product.

We are not concerned with the decision of the hearing examiner on 26 Apr. 1956 to drop the complaint. The burden of proof rests on the Government. But we are astonished at the following statements by the examiner: "From the record as a whole, it appears that we may here be confronted with a device operating upon a principle unknown to or unrecognized by present-day science. The strongest indications of this possibility lie in the scientific testimony in support of the complaint, wherein the scientists admitted that they did not understand the theory upon which the Evis Water Conditioner purports to operate. . . ." *Mirabile dictu!* And ". . . we must not take the risk of interfering with the development of a device which may prove to be the first practical application of a scientific principle heretofore undiscovered." And "We cannot . . . justify the issuance of an order which might act as a brake on the wheels of progress."

Nature is inexorable; it punishes the child who unknowingly steps off a precipice quite as severely as the grown scientist who steps over, with full knowledge of all the laws of falling bodies and the chances of their being correct.—HENRY A. ROWLAND.

James B. Macelwane, Seismologist and Teacher

James Bernard Macelwane was born in Port Clinton, Ohio, in 1883. In 1903 he joined the Jesuit Order, and until 1918, when he was ordained, he was engaged in the arduous training of his order, in the classics, science, and theology. From 1912 he was instructed in physics at St. Louis University. About 1920 he proceeded to the University of California, where he studied under the late Elmer E. Hall, attaining the degree of doctor of philosophy in 1923.

While he was in St. Louis, Father Macelwane became interested in the seismographic station there and wrote his first scientific paper on the "Physics of the seismograph." There followed a number of papers. One was on the "Jordan sunshine recorder," showing his interest in meteorology. In 1918 appeared "The geology of St. Louis."

Father Macelwane's interests were broad. His doctor's thesis was a study of the surface waves of a California earthquake and their change in character as they progressed around the earth. This required the borrowing of seismograms from around the world. In this project he sought the aid of the late Andrew C.

Lawson, chairman of the geology department at the University of California. The university had maintained two seismographic stations since 1887, but the charge of them had been in the hands of astronomers, engineers, and geologists throughout the years. Lawson decided that it was time to put a trained seismologist in charge and persuaded the Jesuit Order to allow Macelwane to remain 2 years after he obtained his Ph.D. degree to reorganize the seismographic stations and train a man to take his place when he returned to St. Louis. I was that man. Father Macelwane, with his indomitable energy and persistence, aroused an interest in expanding and improving the stations, which resulted some years after his return to St. Louis in the establishment of two new stations and new equipment for the old.

On his return to St. Louis, Father Macelwane took charge of seismological work there. He added a second station (Florissant) and entered on a program of developing new seismographs. One of his students, the late William Sprengnether, began to manufacture the new instruments. Macelwane revived the Jesuit

Seismological Association (formerly called the Jesuit Seismological Service) and was its president throughout the remainder of his life. He organized geophysical curriculums in St. Louis and was dean of the Institute of Technology. Some 25 Ph.D. theses on geophysical subjects were written by Macelwane's students at St. Louis.

But organization of activities within his order and his university was only one part of Father Macelwane's activities. He played a large part in national geophysical activity. He was chairman of the committee of the National Research council that produced bulletin 90, *Seismology*. He was also a contributor to the *Interior of the Earth*, the first edition of which was a National Research Council publication. He was a panel chairman with the Research and Development Board. He was active in advising the Navy about the use of microseisms in tracking hurricanes. The tripartite method was Macelwane's own. At the time of his death he was a member of the National Science Board and chairman of the technical panel on seismology and gravity of the U.S. National Committee for the International Geophysical Year.

Father Macelwane served as president and was a member of the board of editors of the Seismological Society of America. At the time of his death he was president of the American Geophysical Union. He was a member of the National Academy of Sciences and of a dozen other societies and academies.

He died in St. Louis on 15 February 1956. His was a rich and active life.

PERRY BYERLY
Department of Geological Sciences,
University of California

He is still at play, save only that his play is such as manhood stops to watch, and his playthings are those which the gods gave their children. The universe is his box of toys. He dabbles his fingers in the day-dust. He is gold-dusty with trembling amidst the stars. He makes bright mischief with the moon. The meteors nuzzle their noses in his hand. He teases into growling the kennelled thunder, and laughs at the shaking of its fiery chain. He dances in and out of the gates of heaven; its floor is littered with his broken fancies. He runs wild over the fields of ether. He chases the rolling world. He gets between the feet of the horses of the sun. He stands in the lap of patient Nature, and twines her loosened tresses after a hundred wilful fashions, to see how she will look nicest in his song.—FRANCIS THOMPSON,
describing Shelley. Quoted by A. S. Eve as applicable to Lord Rutherford.

News of Science

Visit to Moscow

The American physicists who recently spent 10 days in Moscow [123, 834 (11 May)] report that they were permitted to visit any physics experimental facilities and laboratories they desired.

"They asked us to tell them what we wanted to see," one scientist said. "We saw everything we wanted. They answered every question. We were permitted to bring our cameras right into their experimental laboratories and take pictures of everything we wanted."

Members of the group also learned of the difficulties that many Soviet scientists encountered during the Stalin era. Some of the most brilliant physicists were kept under surveillance, arrested, or exiled during the years between the end of World War II and Stalin's death. Victor F. Weisskopf of the Massachusetts Institute of Technology, who speaks Russian, said Soviet research was already benefiting from the return to universities and institutes of scientists who had been held in labor camps. He commented that the release of prisoners, both scientists and ordinary citizens, had gone far to eliminate the atmosphere of fear in the country.

One American who had extensive private conversations with one of the most distinguished Soviet research men said that he was amazed to find that "Russia had its own versions of the Oppenheimer case. . . . I learned of Russian scientists who were subjected to similar treatment—or worse—by the Soviet Government because they refused to engage in certain lines of weapons research which the Government demanded."

Jack Steinberger of Columbia University said that the Soviets had already virtually assured a world lead in high-energy physics for the next decade. He commented that the U.S.S.R. had achieved this position by winning an equipment and construction edge over the United States. Steinberger described the new physical research center, the Institute for Nuclear Problems and the Electro-Technical Institute, that is being built at Bolshaya Volga, near the junction of the Moscow-Volga canal and the upper Volga River.

The center has a 680-Mev cyclotron that Steinberger said was superior to

similar American machines. The visitors also saw a new 10-Bev accelerator that is virtually complete but has not yet gone into operation. This machine is almost twice the size of the largest comparable American facility, the 6-Bev accelerator at Berkeley, Calif.

Steinberger said that the Soviet apparatus weighs about 4 times more than the Berkeley apparatus, cost well over \$100 million, and was built in about half the time it would have taken in the United States. However, despite the excellence of Soviet equipment, Steinberger felt that the level of Soviet experimental work was no higher than in the United States and in some respects possibly inferior.

An editorial in a recent issue of the Washington D.C., *Evening Star* made the following comment about the Moscow visit.

"Such information is well worth having, and it points up the value of exchanging visits with the Soviet Union along the lines advocated by President Eisenhower. This two-way street to knowledge can be traveled without endangering our security; indeed, it may actually help us in that sense. There is no monopoly in the field of abstract or applied science. We can learn from the Russians just as they can learn from us. It would be narrow-minded of us, and self-denying, if we insisted upon maintaining a wall of intellectual censorship between our two countries.

Biological Effects of Atomic Radiations

Summary reports of a year-long study of the biological effects of atomic radiations were released 13 June by the National Academy of Sciences. The reports, which are the first in a series of continuing studies, were prepared by committees of scientists in each of the following fields: genetics, pathology, meteorology, oceanography and fisheries, agriculture and food supplies, and disposal and dispersal of radioactive wastes. The chairmen of the respective committees were Warren Weaver, vice president for the natural and medical sciences of the Rockefeller Foundation; Shields

Warren, director of the New England Deaconess Hospital, Boston, Mass.; Harry Wexler, director of meteorological research of the U.S. Weather Bureau; Roger Revelle, director of Scripps Institution of Oceanography; A. Geoffrey Norman, professor of botany at the University of Michigan; and Abel Wolman, professor of sanitary engineering at Johns Hopkins University. The committees were appointed by Detlev W. Bronk, president of the NAS, and the work was supported by a grant from the Rockefeller Foundation.

The reports summarize present knowledge in the six fields and point out areas in which further research is most needed. The full report of each committee is to be published in monograph form by the NAS at a later date. The texts of the summary reports are available now from the NAS; they will also be published in subsequent issues of *Science*. A brief summary of some of the findings and recommendations follows.

Atomic weapons testing has not raised world-wide radiation to levels significantly greater than those resulting from natural radioactivity and dental and medical use of x-rays. Since all radiation is harmful, the dose should be kept as low as possible. Records should be kept of every individual's exposure to x-rays and other gamma radiation. Medical experts should initiate a vigorous movement to reduce exposure to x-rays to the lowest limit that is consistent with medical necessity. Humanly controllable sources of radiation should be restricted so that the general population shall not receive from such sources more than 10 roentgens, in addition to background, as a total accumulated dose from conception to age 30.

Improved techniques for monitoring world-wide fallout should be developed. Any large increase in the release of strontium-90 might be a matter for serious concern.

One of the pathological effects of radiation is a general increase in the rate of aging and a consequent shortening of life. Dose levels such as those the geneticists believe reasonable, or as have been established for persons working with radiation, have not been shown to have this effect.

Radiation from fallout inevitably contaminates the food supply. At present, the contamination is negligible, but the maximum tolerable level of radioactivity in food is not known.

Research through the use of radioactive tracer materials offers promise in the study of biochemical reactions, in the charting of ocean and air currents, and in the study of interrelationships among marine animals. However, such investigations may be possible only within the next 10 to 20 years, for in-

creasing radioactive contamination of the sea and atmosphere may make the detection of tracers impossible.

The accumulated radioactive waste products of a world-wide atomic power industry may represent more radiation than would be released in an atomic war. A national agency should control and keep records of all dumping of radioactive material in the ocean, and an international body should set up without delay safe standards, based on present knowledge, for the marine and air disposal of waste materials.

Accelerated research is needed in the following fields: genetics; radiation pathology; mixing between various parts of the atmosphere and the oceans; the concentration of radioactive materials by plants and animals; the geophysical and geochemical aspects of the ultimate disposal of radioactive wastes; the selection of biologically suitable sites for various atomic facilities; and safety devices for the control of accidental power surges in nuclear reactors.

Accidents in Nuclear Work

The British Atomic Energy Authority has announced that Graham Hawkins, a senior experiment officer, died of an electric shock suffered during tests of the Harwell Research Center's new proton particle accelerator. Hawkins was the first victim of a research accident at Harwell.

A serious breakage a year ago in Britain's biggest atomic explosives factory, and the heroism of 251 volunteers of the staff who kept the plant going, has also been reported. The volunteers, working in the face of intense radioactivity, welded a broken plate in a reactor and maintained production. They took turns manipulating welding equipment at the ends of 60-foot flexible arms thrust through holes in a protective screen.

The volunteers, both men and women, were allowed to work only a few minutes at a time—and in that time received the equivalent of 2 weeks of radiation exposure.

The accident occurred in one of two reactors at Sellafield, which makes plutonium. If the plant had been shut down, Britain would have lost a large part of her plutonium output.

Another accident, fortunately far less serious, has been reported in the United States. The Atomic Energy Commission announced recently that at least 15 persons, workmen and others engaged in the construction of a power reactor, had been exposed to "small doses" of gamma radiation at Fort Belvoir, Va., but that the amount was "not serious."

The AEC said that a bit of radioactive iridium, used in the x-ray examination

of welds, "was removed from its shielded container and, contrary to standard practice, left unshielded for about three hours. . . . The amount of radiation to which the men were exposed was considerably lower than any which could result in an observable clinical effect."

What Happens to Science Fair Participants?

Alan T. Waterman made the following observations about the future of high-school science students in a speech delivered at the recent National Science Fair in Oklahoma City, Okla.

"So perceptive are the judges who evaluate your exhibits that I am able to read your futures. Would you like to know what you will be doing in the next few years? Of the 213 present at this Seventh National Science Fair, 187 of you will actually become scientists or engineers. . . . So expert has been the selection of former judges that we know that 88 percent of those whom they send to the national competition will go on to make science or engineering their career.

"A survey of the 248 young people named as finalists in the first five National Science Fairs developed the following information: of 85 percent who replied, 131 were in colleges or other institutions of higher learning, attending 83 institutions in 28 states, 58 were still in high school, 12 were in full-time employment, eight were in the armed service, and four were devoting full time to homemaking and child care. Interesting to you will be the career choices of the 131 college students: 41 were in physical science (chemistry 27, physics 13, biochemistry 1), 31 in engineering, 28 in biological science and medicine, 13 in miscellaneous science, and 10 in miscellaneous non-science."

Recent Archeological Finds

Salim Abdel Abdulhak, head of the Syrian Archaeological Department, Damascus, Syria, has reported the discovery of the 4000-year-old seaport city of Semira, which he describes as a "treasure mine of Phoenician, Aramean, Assyrian, and Greek archaeological finds." The city, which is in northern Syria, vanished at about the end of the Greek Empire, before the birth of Christ. United States, French, British, and Belgian expeditions have been trying to find it for a century but failed because they excavated along the seacoast. Semira was located about 3 miles inland, probably as protection against pirates.

Other recent archeological finds are seven Roman graves in Yugoslavia and a large source of Stone Age flint instru-

ments in Jordan. The graves were excavated in a park near St. Mark's Church in the center of Belgrade. They bear the seal of a Roman legion and date from the second to the fourth centuries A.D. They appear to have been plundered by grave robbers, perhaps several centuries ago.

Workers clearing a spring under the direction of the United States International Cooperation Administration made the flint find at Qasr Azraq oasis, about 50 miles east of Amman. More than 500 artifacts of many sizes have been excavated and the workmen continue to turn them up. Some of the items appear to date back to the Lower Palaeolithic period, about 200,000 years ago. The flints are principally oval or roundish hand-axes, ranging in size from 2 inches across to one of approximately 10 inches. This source of prehistoric instruments is considered to be one of the richest ever discovered.

Signals from Venus

The planet Venus has been heard from for the first time. Several times during May Ohio State University's Radio Observatory received strong radio signals. On each occasion the signals, crackling sounds like static, were observed distinctly for a period of several hours.

Venus, which is often called the earth's twin, is nearly the same size as the earth and comes closer to it than any other planet. In the evening it is the brightest object in the western sky. Before 22 June it was approaching the earth at the rate of 500,000 miles per day; on that date it reached its nearest point, 27 million miles, and then started to recede.

Conditions on Venus are not known because it is perpetually covered by clouds. The planet is the second from which radio signals have been received. Last year observers at the Carnegie Institution, Washington, D.C., picked up radio sounds from Jupiter, and since early this year studies of the Jupiter signals also have been made at Ohio State.

Assistance for Germany

Franz Josef Strauss, German Minister for Atomic Problems, recently said of his visit to the United States:

"As compared to the big nations of the world we have a backlog of 10 to 15 years with regard to the peaceful development of nuclear energy. The gate leading to the atomic era is closed to us, as it were. To open it, and to catch up with international developments more speedily, we need the assistance of the big

powers, above all of the U.S.A. If I spoke of myself as of a 'can-opener'—a word which was taken up with some relish by the American newspaper men—I meant to say that my visit to the U.S.A. was not intended to be a sight-seeing trip, but that it was to serve the purpose of obtaining American assistance for overcoming this backlog as quickly as possible.

"The Americans have offered to give us as a gift a complete library on atomic literature. Moreover, they gave us to understand that we may avail ourselves of the President's offer, extended to all countries receiving American assistance in respect to nuclear research, to participate in the purchase of research reactors up to a total sum of \$350,000, taken from American funds.

"I met my namesake Admiral Strauss a number of times: Three times at social functions, at which political or rather nuclear conversations took place, and twice at official meetings. I was much pleased to find that Admiral Strauss has full understanding for our desire to get ahead quickly and that he is willing to examine sympathetically our plans and to submit them to the U.S. Atomic Energy Commission. He said, moreover, that he was prepared to let me know in detail the measures the United States is planning for our assistance in this field."

Ford Committee

The Ford Foundation has announced the appointment of a special committee to recommend a plan for distribution of the foundation's appropriation of \$90 million to the nation's privately supported medical schools. The appropriation is part of the \$500 million grant announced last December for college faculty salaries, private hospitals, and medical schools, and is entirely apart from the \$10 million appropriated in April for the National Fund for Medical Education.

Lee DuBridge, president of the California Institute of Technology, will serve as chairman of the medical school grants advisory committee. Executive chairman will be Carlyle Jacobsen, executive dean for medical education at the State University of New York. Other members of the committee are: George P. Berry, dean of the Harvard University Medical School; Detlev W. Bronk, president of the National Academy of Sciences and the Rockefeller Institute; Leonard Carmichael, secretary of the Smithsonian Institution; Ward Darley, president of the University of Colorado; John H. Dingle, professor in the School of Medicine, Western Reserve University; Leon Falk, Jr., chairman of the board, Maurice and Laura Falk Foundation, and director of the National Steel Corporation, Pittsburgh, Pa.; A. Crawford Green, at-

torney, San Francisco; Robert M. Hanes, president of the Wachovia Bank and Trust Company, Winston-Salem, N.C.; Mrs. Albert D. Lasker, president of the Albert and Mary Lasker Foundation, New York; Robert F. Loeb, professor of medicine at Columbia University; William F. Loomis, director of the Loomis Laboratory, Greenwich, Conn.; Franklin D. Murphy, chancellor of the University of Kansas; and Robert W. Woodruff, chairman of the finance committee, Coca-Cola Company, Atlanta, Ga.

Index to Science

The volume index to *Science*, which has customarily appeared in the last issue of a volume, will henceforth appear in the fourth issue of the month following the close of a volume. The index for volume 123, January-June 1956, will be included in the issue of 27 July.

News Briefs

■ The new building for *Chemical Abstracts* at Ohio State University was dedicated on 8 June. The structure is perhaps the first ever planned exclusively for an abstracting and indexing service. Officers and directors of the American Chemical Society, which publishes *Chemical Abstracts*, and officers and trustees of the university, which has housed the publication since 1909, took part in ceremonies that were held at the main entrance to the three-story, 67-room building.

A prominent participant in the dedication was E. J. Crane, director of the Chemical Abstracts Service, who joined the editorial staff upon his graduation from Ohio State in 1911 and became editor in 1915. Under his leadership the publication has achieved such massive proportions that this year it will carry 90,000 abstracts of articles in 7000 scientific and technical periodicals that come from 85 countries and involve 40 languages.

■ Lord Chorley, president of the Association of University Teachers in Britain, observed recently that high-salaried American university professorships and research fellowships had tempted a large number of scientific teachers and students to cross the Atlantic. Chorley commented: "Unless we are careful, a large amount of the cream will be skimmed off and deposited in the United States." In addition, American firms have been advertising scientific posts extensively in British newspapers.

■ The British Atomic Energy Authority recently invited scientists from industrial research concerns to a meeting on controlled thermonuclear energy. Hereto-

fore all work on this subject has been as secret in Britain as it is in the United States.

■ Maynard M. Boring, president of the American Society of Engineering Education, said in a recent address before the National Society for Professional Engineers, that "much hysteria" had surrounded the subject of engineer shortage. Boring, who is also manager of technical personnel development for the General Electric Company, Schenectady, N.Y., referred to industry's contention that it needed 68,000 more engineers and declared:

"I think there is too much water in their figures. . . . If we had a 10 percent drop in our economy, we would have engineers raining out of our ears." He also said that if 68,000 engineers were provided for industry, "they wouldn't know what to do with them."

Referring to general education, the speaker, who recently toured Europe studying educational processes in various countries, commented that "We are really in trouble in the United States." He attributed this situation to the fact that high-school students in this country were not being properly prepared for college.

Scientists in the News

DONALD H. LOUGHridge, formerly dean of the Technological Institute at Northwestern University, has recently accepted an appointment as special executive assistant at the new General Motors Technical Center.

IRVING KAPLAN, senior scientist and head of the reactor division of the nuclear engineering department at the Brookhaven National Laboratory, has been appointed Gordon McKay visiting lecturer at Harvard University for the fall term. He will replace HARVEY BROOKS, who has been granted a Guggenheim fellowship for the coming year. Brooks will be engaged in research at the Cavendish Laboratory in Cambridge, England.

STELLA L. DEIGNAN, director of the Bio-Sciences Information Exchange, Washington, D.C., has received a certificate of appreciation from the American Cancer Society in recognition of the services rendered the cancer control movement by Dr. Deignan and her staff in collecting, indexing, and dispensing information on medical research. The services of the office are free to recognized scientists and research institutions, as well as to 80 voluntary agencies that support investigation of health problems.

The Bio-Sciences Information Ex-

change, which is attached to the Smithsonian Institution and financed by seven Government agencies, is a clearing house of information. Its files are coded under 80 categories and 4132 subcategories that range from aging to viscosity.

Any reputable scientist or agency can obtain a résumé of research being done on any subject by writing to Dr. Deignan. A staff of 34 workers of various categories prepare and send out the answers.

None of the information supplied by the BSIE may be published—some of the material is little more than an idea in a scientist's mind that may not appear in a professional journal for years. To prevent plagiarism, those receiving information of value are required to advise the scientist from whose work they benefit.

The office serves several purposes. It tells researchers what work already has been done on their problem and puts them in touch with other scientists in the same field. It also lists the past and present support received by every applicant for a research grant. In this way, it helps prevent duplication of both research and research support. Brief abstracts are on file of every project sponsored by 80 major research-financing organizations.

LEO MARION, director of the Division of Pure Chemistry of the National Research Council of Canada, has received the Chemical Institute of Canada medal for 1956. The medal, which is awarded annually for outstanding contributions to Canadian chemistry and chemical engineering, is sponsored by the International Nickel Company of Canada, Ltd.

The following are among those who have recently received honorary doctoral degrees.

Lynchburg College: A. B. MASSEY, the Wildlife Unit, Virginia Polytechnic Institute.

Union College: JOSÉ DE ASSIS RIBEIRO, president, South American General Electric Company.

Syracuse University: CARL L. BAUSCH, senior vice president, Bausch and Lomb Optical Company.

Carnegie Institute of Technology: LEWIS L. STRAUSS, chairman of the U.S. Atomic Energy Commission; JAMES B. FISK, executive vice president of the Bell Telephone Laboratories; JAMES H. KINDELBERGER, chairman of the board, North American Aviation; LON H. COLBORN, chemistry teacher, Taylor Allderdice High School, Pittsburgh, Pa.

College of Wooster: JOSEPH E. HENDERSON, director of the Applied Physics Laboratory, University of Washington.

MAX B. LURIE, professor of experimental pathology at the Henry Phipps Institute of the University of Pennsylvania, has received the 1956 Trudeau medal from the National Tuberculosis Association in recognition of his studies in native and acquired resistance to tuberculosis.

Winners of awards for the five best essays on gravity have been announced by the Gravity Research Foundation, New Boston, N.H. FREDERIK J. BEL-INFANTE, professor of Theoretical Physics at Purdue University, received the first award of \$1000. The remaining awards were made as follows: STEPHEN W. GRAY, associate professor of anatomy at Emory University, \$300; RICHARD BLYTHE, physicist at the Willow Run Laboratories, University of Michigan, Ypsilanti, \$200; FRANK J. LOW, a graduate student at the Rice Institute, \$150; and SIDNEY A. BLUDMAN, a theoretical physicist at the University of California Radiation Laboratory, \$100.

BENJAMIN BOSS, director of the Dudley Observatory of Union University, will retire in July after 48 years of continuous service. He succeeded his father when the latter died in 1912. The present Prof. Boss continued his father's work in determining and cataloging the positions and motions of the stars, so that the project grew to include more than 33,000. These are recorded in the five-volume *General Catalog* that was published in 1937. This work consolidated the mass of prior calculations which appeared in the *San Luis Catalog* of 15,333 stars that was published in 1928 and the *Albany Catalog* of 20,811 stars that was published in 1931.

In the course of his career, Boss has made a number of significant discoveries. One of these, the fanning out of the stars in a skew formation toward one hemisphere of the sky, confirmed the rotation of the Milky Way. He also discovered a group of stars in the constellation Taurus and another in Perseus. Other research has dealt with the relationship between the candle power of stars, their motion toward or away from the earth, and their distribution with reference to the Milky Way.

ABRAHAM FLEXNER, whose report on medical education in 1910 led to the overhauling of American medical schools, has received the Frank H. Lahey memorial award. The award, which is sponsored jointly by the National Fund for Medical Education, the American Medical Association, and the Association of American Medical Colleges, is given periodically for "outstanding leadership in medical education."

KARL M. BOWMAN, a psychiatrist, has announced his retirement as medical superintendent of the University of California's Langley Porter Clinic, which he joined 15 years ago. Before that he was director of psychiatry at Bellevue Hospital in New York and a professor at New York University. He has devoted many years to research in psychiatry, particularly for the armed forces, and has done extensive work on the problem of alcoholism.

JAMES W. TURNBOW, assistant professor of engineering mechanics at the University of Texas, has received the Convair award for excellence in engineering teaching.

WINSTON H. BOSTICK, associate professor of physics at Tufts College, has been appointed professor and head of the department of physics of Stevens Institute of Technology. At present Bostick is on leave from Tufts to conduct research for the Atomic Energy Commission at the Radiation Laboratory of the University of California. His special field of work there has been the study of the interaction of plasmas and magnetic fields. Bostick is the inventor of a "plasma gun," which shoots bursts of high-speed plasma through a magnetic field for laboratory study.

DAVID EHRENFREUND, associate professor of psychology at the State College of Washington, has been appointed chairman of the psychology department at Adelphi College.

Recent Deaths

NATHAN I. BERGER, New York, N.Y.; 83; retired chemical consultant; 2 June.

BURGHARD BREITNER, Innsbruck, Austria; 72; professor of surgery at Innsbruck University; president of the Austrian Red Cross since 1950; 28 Mar.

GEORGE H. CLARK, New York, N.Y.; 75; electrical engineer; pioneer in wireless telegraphy who had been with the Radio Corporation of America since 1919; 3 June.

THOMAS A. COLE, Poughkeepsie, N.Y.; 72; bacteriologist; formerly superintendent of the Poughkeepsie city water filtration plant; 26 May.

OSCAR A. DE LONG, Upper Montclair, N.J.; retired electrical engineer; 31 May.

ALPHEUS M. GOODMAN, Ithaca, N.Y.; 71; emeritus professor of agricultural engineering at Cornell University; 28 May.

JAMES L. HEAD, Douglas Manor, N.Y.; 61; retired mining engineer; 3 June.

HARVEY F. MACK, Easton, Pa.; 77; pioneer in the printing of scientific periodicals; 29 May.

CARL NEUBERG, New York, N.Y.; 78; research professor of biochemistry at New York Medical College; former director of the Kaiser Wilhelm Institute of Experimental Therapy in Berlin and of the Kaiser Wilhelm Institute for Biochemistry at Dahlem; founder of the journal *Biochemische Zeitschrift*, the first journal devoted exclusively to the biochemical sciences; discoverer of a process for making glycerin from sugar, which led to the commercial production of nitroglycerin by yeast fermentation; 30 May.

ROBERT N. RANDOLPH, Westfield, N.J.; mechanical engineer for 33 years with New Jersey Bell Telephone Company; 31 May.

DAMASO DE RIVAS, Tallahassee, Fla.; 81; former professor of pathology at the University of Pennsylvania Medical College; specialist in tropical diseases; 28 May.

NELSON G. RUSSELL, Buffalo, N.Y.; 83; professor of medicine emeritus at the University of Buffalo Medical School; 4 June.

PERCY F. SMITH, Hamden, Conn.; 88; James E. English emeritus professor of mathematics and chairman of the department at Yale University; 3 June.

MALFORD W. THEWLIS, Wakefield, R.I.; 66; pioneer in geriatrics; founder of the American Geriatrics Society; 3 June.

WILLIAM C. WOOD, Philadelphia, Pa.; 70; professor emeritus of otolaryngology at the University of Pennsylvania Graduate School of Medicine; 4 June.

Education

■ The Alfred P. Sloan Foundation, Inc., has made a grant of \$150,000 to the Menninger Foundation, Topeka, Kan., in support of the Menninger School of Psychiatry. This is the foundation's first sizable commitment in the field of mental health.

The Menninger School is observing its tenth anniversary this year. Since its establishment, 500 physicians have been enrolled in its 3- to 5-year training program, and as of 1 July 140 fellows will be studying there.

■ Indiana University has dedicated its new David Starr Jordan Hall of Biology. The \$5.8 million teaching and research center for bacteriology, botany, and zoology honors the late Dr. Jordan, who was professor of zoology at the university and its president before he assumed that post at Stanford University. Forty-five scientists read papers during the dedication ceremonies.

■ A basic research project in insect taxonomy, specifically designed for the preparation of taxonomic monographs on United States parasitic wasps, has started under the joint sponsorship of the University of Michigan and the Dow Chemical Company. The university has provided laboratory space and general facilities for the work in its Museum of Zoology at Ann Arbor, and Dow is providing funds.

The project director is Henry Townes, who has joined the university staff as a research associate; he formerly served as associate professor of entomology at North Carolina State College, Raleigh. Associated with Townes is Robert R. Dreisbach, Dow consultant and a specialist in insect taxonomy.

Initial work will be devoted to the family Ichneumonidae, which includes about 7500 species of which about two-thirds are still unnamed. Cooperation with research workers in other institutions will be freely sought and freely given.

■ The University of Michigan has received \$178,750 from the Herbert H. and Grace Dow Foundation of Midland, Mich., for the establishment of a television system in the University Hospital. Equipment will include a regular portable black and white camera, a film camera that will project color slides and films to class rooms, control equipment, and a special color camera that will be mounted over the operating table.

Although the system will be used primarily to telecast on a closed circuit, it will be color compatible, and thus it will be possible to telecast, nationwide if necessary, through local commercial stations in either color or black and white. It will also be possible for other hospitals throughout the state to purchase special closed-circuit receiving apparatus for seeing programs on the hospital television circuit.

■ The Argonne National Laboratory reports that 76 faculty members and 41 students, representing 63 American educational institutions, have been accepted for summer employment. The laboratory, which is operated for the U.S. Atomic Energy Commission by the University of Chicago, makes such appointments annually to encourage research and to strengthen teaching in fields related to atomic energy.

In addition, 61 faculty members from 36 American engineering colleges and universities are enrolled in a 2-month nuclear energy institute that will be held at the laboratory beginning 25 June. The institute, the first of its kind, is being sponsored jointly by the laboratory, the Atomic Energy Commission, the American Society for Engineering Education,

the National Science Foundation, and Northwestern University. The purpose of the institute is to provide engineering college faculty members with training that will help them to incorporate nuclear engineering material into their courses of instruction.

■ The University of New Mexico has announced that next fall it will operate a graduate training center at the Los Alamos Scientific Laboratory. Contract negotiations between the university and the University of California, which operates Los Alamos for the U.S. Atomic Energy Commission, have been completed. The purpose of the graduate center is to provide a program of courses leading to the master of science degree in the fields of physics, chemistry, mathematics, and engineering.

John F. Suttle, associate professor of chemistry at the University of New Mexico, will be resident director of the program at Los Alamos; he will begin his duties on 1 Aug. The new center will differ from the present graduate program sponsored by the University of New Mexico in that students may attain the M.S. degree with residence entirely at Los Alamos.

Previously, laboratory employees had to interrupt their employment so that they might complete their residency requirements at Albuquerque. To meet requirements for the Ph.D. degree, it will still be necessary for the candidate to have at least two consecutive semesters of residence on the University of New Mexico campus.

Grants, Fellowships, and Awards

■ The National Research Council of Canada has awarded 27 medical research fellowships for 1956-57. Total value of the awards is \$72,950, plus traveling allowances when required. All fellowship recipients are medical graduates who will engage in research in the medical sciences. Twenty-two of the awards will be held in Canadian universities, four in the United States, and one in England.

■ The Nutrition Foundation, Inc., has announced that nominations are invited for its \$1000 Osborne and Mendel award, which was established to recognize exploratory research in the science of nutrition. The award will be given to the investigator who has made the most significant published contribution in the year preceding the annual meeting of the institute, or who has published a series of contemporary papers of outstanding significance.

As a general policy, the award will be made to one person; however, if in the judgment of the jury of award an in-

justice would otherwise be done, it may be divided among two or more persons. Normally preference will be given to research workers in the United States and Canada, but investigators in other countries, especially those sojourning in the United States or Canada for a period of time, are not excluded from consideration. Membership in the Institute of Nutrition is not a requirement for eligibility and there is no limitation as to age.

Nominations may be made by anyone. Information submitted must include as convincing a statement as possible regarding the basis of the nomination (this may include a pertinent bibliography, but reprints are not required). Five copies of all documents, including seconding statements, must be sent before 1 Jan. 1957 to the chairman of the Nominating Committee, R. V. Boucher, Agricultural and Biological Chemistry, Pennsylvania State University, University Park, Pa.

■ Applications will be accepted through 4 Sept., for the second group of senior postdoctoral fellowships to be awarded by the National Science Foundation during the current calendar year. Fellowships will be awarded in mathematical, physical, medical, biological, engineering, and other sciences, including anthropology, psychology (other than clinical), geography, certain interdisciplinary fields, and areas of convergence between the natural and social sciences. Names of successful fellowship candidates will be announced on 16 Oct.

To be eligible for these awards, candidates must be citizens of the United States with demonstrated ability and special aptitude for advanced training and productive scholarship in the sciences. In addition, candidates must have at least 5 years' experience beyond the science doctorate or its equivalent. Annual stipends of from \$2000 to \$10,000, adjusted to match as closely as feasible the regular salaries of the award recipients, may be applied toward study or research in an accredited nonprofit institution of higher learning in the United States or abroad. A limited allowance to aid in defraying costs of travel for a fellow and his dependents will also be available. Applications and further details may be obtained from the Division of Scientific Personnel and Education, National Science Foundation, Washington 25, D.C.

In the Laboratories

■ A 4-day open house was held last month at the new instrument manufacturing plant in North Wales, Pa., of the Leeds and Northrup Company. Guests included industrialists and scientists, as well as employees and their families. Se-

curity regulations did not permit invitations to the general public.

A highlight of the program was a demonstration of combined 18th and 20th century electric instruments. This was arranged in cooperation with the Franklin Institute as a tribute to Benjamin Franklin, whose 250th birthday is being recognized this year by organizations throughout the world.

The plant will be devoted entirely to manufacture of Speedomax recorders and recorder controllers, Metermax combustion controls, L&N load-frequency controls, and certain other automatic instrumentation widely used by science and industry. Manufacturing operations employ standard machine tools, engravers, winding machines and molding machines, and such operations as heat-treating, spraying and lacquering, connecting, calibrating, testing, assembling, and tool and die making. Because of the wide variety of products, mass-production techniques are seldom used.

The manufacturing and office areas are a single-story building with partial mezzanine, providing more than 6 acres of floor space. Walls are of brick and insulated metal siding, with glare-resistant windows. The plant was designed by Giffels and Vallet Inc., L. Rossetti, Detroit.

Buildings and land, a 129-acre tract, cost about \$4 million; inventory and equipment about \$7 million more. There will be about 1300 employees at North Wales, including not only some of the firm's manufacturing people but also some from the departments of engineering, industrial engineering, personnel, accounting, and maintenance.

■ Texas Instruments Incorporated, Dallas, will acquire the William I. Mann Company on 30 June. Mann has been in business for 9 years and is the largest western producer of precision optical components that are used in scientific and military instruments, guided missiles, and projection devices. The company employs about 100 people and has yearly sales of approximately \$800,000. All manufacturing facilities are located in Monrovia, Los Angeles County, Calif.

■ Olin Mathieson Chemical Corporation's new experimental unit for the production of synthesis gas by partial oxidation of coal went into operation recently at Morgantown, W.Va. Although it will be used for experimental purposes only, the unit will be capable of producing synthesis gas in the amount required to manufacture approximately 80 tons a day of ammonia or equivalent methanol.

Ammonia is used in the manufacture of fertilizers, plastics, synthetic fibers and other chemicals, while methanol is used in automotive antifreeze and as a solvent.

The partial oxidation process is expected to eventually replace the present process for making synthesis gas at Morgantown.

The process was developed by the Texaco Development Company. It is now in commercial operation elsewhere using natural gas and fuel oil as raw materials, and a small pilot unit has operated successfully on coal. The Morgantown experimental unit will determine the feasibility of commercial-scale operation using coal.

Miscellaneous

■ The Federal Government has just completed the indexing of all fishery publications from 1871, the year the Government took official interest in commercial fishing, to 1954. Topics range from the control of fungus on pike eggs to how to cook shrimp. The publication, Fish and Wildlife Service Circular 36, can be obtained for \$1.50 from the Government Printing Office, Washington 25, D.C.

■ The International Commission on Zoological Nomenclature has announced that beginning 12 Dec. it will start voting on the following cases involving the possible use of its plenary powers for the purposes specified against each entry. Full details were published on 12 June in the *Bulletin of Zoological Nomenclature* (vol. 12, pts. 1 and 2): (i) *Paradoxides* Brongniart, 1822, validation; *Olenus* Dalman, [1827], designation of type species for; *paradoxus* Linnaeus, 1759 (*Entomolitus*), suppression, and *PARADOXIDEN* Emmrich, 1844, (wrongly based on *Olenus*) suppression (Cl. Trilobita); (ii) *munda* Kuhl, 1820 (*Proc. [ellaria]* and *Nectris*), suppression (Cl. Aves); (iii) *Daira* de Haan, [1833], validation (Cl. Crustacea, Order Decapoda); (iv) *tuberculatus* Hall, 1859 (*Acidaspis*), validation; *Acanthaloma* Conrad, 1840, suppression (Cl. Trilobita); (v) *Theridion* Walckenaer, 1805 (Cl. Arachnida), designation of type species for; (vi) *Protopeltura* Brögger, 1822 (Cl. Trilobita), designation of type species for; (vii) *punctata* (*Querquedula*), validation of, as from Slater (P.L.), 1880, as name for the Hottentot Teal (Cl. Aves); (viii) *Trinucleus* Murchison, 1839, validation of; *tuberculatus* Link, 1807 (*Trinucleus*), suppression (Cl. Trilobita); (ix) *Panulirus* White, 1847, validation; *commune* Leach, 1818 (*Phyllosoma*) and *risonii* Desmarest (*Palinurus*), suppression (Cl. Crustacea, Order Decapoda); (x) *Illaenus* Dalman, [1827], protection of by suppression of *Cryptonymus* Eichwald, 1825 (Cl. Trilobita). Comments should be sent as soon as possible to the secretary of the commission, Francis Hemming, 28 Park Village East, Regent's Park, London, N.W.1.

Reports and Letters

Interaction of Molybdenum and Iron in Soils

The availability to plants of molybdenum in some acidic soils may be increased by raising the pH of the soil. This relation to pH is analogous to that of phosphate which is held in insoluble form by iron and aluminum, and it suggests a study of the interactions of molybdate with iron and aluminum. This paper (1) is concerned with interactions with iron in simple systems of ferric oxide as well as in soils.

A ferric oxide, which was amorphous to x-rays, was prepared by the method of Schuylenborgh and Arens (2) and ground to pass a 200 I.M.M. sieve. Solutions of sodium molybdate containing 100 μg of Mo were added to 100-mg samples of ferric oxide. The pH 's of the suspensions were adjusted, and the total volume of each was brought to 50 ml. After mechanical shaking of the solutions for 15 hours, the pH 's were determined, the suspensions were centrifuged, and the Mo remaining in solution was determined (3) by the colorimetric-dithiol method of Piper and Beckwith (4). The ferric oxide removed the following amounts of Mo from solution: 100 μg at pH 4, 100 μg at pH 5, 100 μg at pH 6, 98 μg at pH 7, 83 μg at pH 8, and 22 μg at pH 9.

In further experiments with ferric oxide, the amount of Mo adsorbed was determined as a function of the equilibrium concentration of Mo in solution for equilibrium pH 4.5. The adsorption isotherm had a high initial gradient and, at an equilibrium concentration of 50 μg of Mo in 50 ml of solution, it leveled off with a saturation value of about 7 mg of Mo per 100 mg of solid. An aluminum

oxide (Böhmite) prepared by the method of Schuylenborgh (5) was found in similar experiments to be saturated with 3.5 mg of Mo per 100 mg of solid. The difference between the initial gradients was more marked, that for ferric oxide being about 50 times greater than that for aluminum oxide. The effectiveness of the clay minerals in adsorbing molybdate was less than that of the sesquioxides and decreased in the order halloysite, nontronite, and kaolinite.

The fact that ferric oxide adsorbs so much molybdate led to experiments with two soils that were, respectively, high and low in colloidal ferric oxide. The first soil was a krasnozem of pH 5.3 from Wollongbar, near Lismore in New South Wales. It contains 55 percent clay (particle size less than 2 μ) and 14.9 percent free ferric oxide. The other soil, from Elmhurst, near Ararat in Victoria, was a grey, gravelly loam of pH 5.9, overlying yellow clay at 10 in. It has 14 percent clay (particle size less than 2 μ) and 1.1 percent free ferric oxide.

The soils were air-dried and ground to pass a 60-mesh I.M.M. sieve. Samples of 5 g were shaken for 15 hours at adjusted pH 's with solutions containing 500 μg of Mo in a total volume of 50 ml. After the suspension had been centrifuged, the Mo remaining in solution was determined as before. Parallel experiments were performed on 5-g samples of the Wollongbar soil after the free ferric oxide in them had been removed by Jeffries' method (6). In this method, the iron oxide is reduced by nascent hydrogen in oxalic acid, and the iron is then removed in solution.

The results (Table 1) show again that the greatest amounts of molybdate were adsorbed at low pH 's, and that the amounts adsorbed decreased with increasing pH . The untreated Wollongbar soil adsorbed much more molybdate than the Elmhurst soil, and even at pH 7, the Wollongbar soil still adsorbed approximately half of the molybdate presented. The effect of removing the ferric oxide from this soil was striking. The amounts adsorbed were thereby reduced to amounts nearer those adsorbed by the Elmhurst soil. Thus, at pH 6, the adsorption by the Wollongbar soil was reduced from 460 μg to 190 μg , the

amount adsorbed by the Elmhurst soil being 100 μg .

The importance of ferric oxide in soils is shown both by the relatively large amounts of molybdate that it adsorbs in simple systems and by the effect of removing it from the Wollongbar soil. Since adsorption is greatest in acidic systems and becomes less with increasing pH , it is suggested that Mo, in ferruginous soils, is held on the surface of colloidal ferric oxides as the molybdate anion, which is replaceable by hydroxyl ions.

This work fits in with the effect of lime on the availability of Mo to plants on some acidic, ferruginous soils and also with the principle used by Grigg (7) in his analysis for available Mo in soils—namely, that an amount of Mo which is sufficient for plants at pH 6 may be insufficient at pH 5. Another piece of compatible evidence is that presented by Williams and Moore (8) who, by means of chemical analyses of plants and soils, arrived at an equation relating Mo in plants to both pH and iron of soils. Their equation is of the form

$$\log \text{Mo} = a \text{pH} - b \text{Fe} + c,$$

where the Fe was that dissolved by boiling the soil with 6N hydrochloric acid.

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6 February 1956

Effect of Reserpine on Learning and Performance

Reserpine, an alkaloid extract of *Rauvolfia serpentina*, is now widely used in clinical psychiatry. It has been shown that it depresses well-established performance patterns of rhesus monkeys—for example, pressing a bar to avoid shock or to obtain food (1). The present study shows that reserpine can depress "discriminated" or "conditioned" re-

Table 1. Molybdenum adsorbed (μg) from a total of 500 μg by 5-g samples of soils.

Soil	pH				
	4.0	5.0	6.0	7.0	8.0
Wollongbar, untreated	500	498	460	270	80
Wollongbar, minus Fe_{2}O_3	425	340	190	45	0
Elmhurst	450	310	100	20	0

sponses, as well as "operant" responses, and suggests that reserpine depresses learning as well as performance.

The technique employed was the establishment and extinction of a conditioned emotional response to a signal (white noise) that preceded a noxious stimulus (electric shock). We observed the caged animal from an adjoining room through a one-way window, and independently rated responses to the noise and shock on a four-point scale. A rating of "zero" indicated no response, "one" a questionable response, "two" a fairly definite response, and "three" a very definite response. Response was defined as any recognizable change in ongoing behavior. The various responses to the sound included running, crouching, climbing, and lying prone. The pattern of response most commonly conditioned to the sound was a period of running, followed by crouching.

Eight rhesus monkeys, approximately 2 years of age, served as subjects. They were first given eight preconditioning trials consisting of the noise alone. The noise was approximately 25 decibels sensation level (human) and was sounded for 20 seconds on each occasion. The intervals between successive presentations of the noise were randomized, with an average interval of 2 minutes. The following day the monkeys were divided into two groups of four members each, a reserpine-conditioning group and a saline-conditioning group, and given the appropriate injection. A dosage of reserpine was selected (0.75 mg/kg) that is within the range of previous studies in which monkeys were employed and that typically depresses the general behavior of the animal significantly (1, 2). The saline dosage chosen (0.3 ml/kg) was the same in volume as the reserpine solution.

Conditioning was begun 3 hours after injection for the reserpine group. The interval between injection and conditioning for the saline group was of the same order, but it was not carefully controlled. In the conditioning procedure, each presentation of the noise was followed by five short, strong pulses of electric shock (one per second) delivered by a method described elsewhere (1, 3). The injections and conditioning procedures were repeated 2 days later. All animals received ten trials on each of the 2 days.

Three days after the second conditioning day, all animals were tested (without further injections) for "retention" of the conditioning experience. Conditioning trials were presented to a given animal at the rate of ten per day on alternate days, until a series of five successive noise responses was obtained, such that both investigators gave ratings of "two" or "three" to any four of the five responses.

Table 1. Conditioning

Conditioning retention		Conditioning
Reserpine (1)	Saline (2)	Saline (3)
18	0	9
13	0	7
7	0	7
2	0	3

In the study of extinction, the eight animals were again divided into reserpine and saline groups of four members each. The reserpine-extinction group consisted of two members from the reserpine-conditioning group plus two members from the saline-conditioning group, while the saline-extinction group consisted of the remaining two members of each of the two conditioning groups. Injections were given before each session. In the extinction procedure, electric shock was not presented. The trials were given in two sessions of ten each and were separated by 2 days. Three days later, the animals were tested for "extinction retention" by presenting further extinction trials (without injections), ten per day on alternate days, until a series of five successive noise responses was obtained, such that both investigators gave ratings of "zero" or "one" to any four of the five responses.

The following results were obtained. During conditioning, the reserpine group showed only slight deviations from "zero" values in their responses to the noise, although they definitely responded to the electric shock. The saline group showed a definite increase in noise response values. The following figures are the averages of both our ratings for each group of animals during the first ten and the second ten conditioning trials (the numbers in parentheses represent the range of the average ratings for each trial): reserpine group—0.03 (0 to 0.2), 0.17 (0 to 0.4); saline group—1.70 (0.9 to 2.6), 2.40 (1.9 to 2.8).

In Table 1 is listed the number of trials (not including the criterion trials) required for each animal to reach the retention criterion. All saline animals had perfect retention (column 2), while all

reserpine animals required additional training (column 1) (this difference is significant at the 0.05 level by the Mann-Whitney test). Column 3 lists the number of trials in which the saline animals achieved criterion performance, if computations are made from the beginning of the conditioning period. This is a measure of how long it took control animals to learn this particular habit. By comparing the reserpine retention scores with the scores in column 3, one can determine whether the reserpine animals benefited from their experience under the drug. It can be seen that the difference between column-1 and column-3 scores is not significant, although the reserpine mean (and variance) is slightly larger.

In extinction, the reserpine group again showed considerably lower noise-response values than the saline group, regardless of which drug had been used during conditioning. The average ratings and ranges for the first ten and second ten extinction trials were as follows: reserpine extinction-reserpine conditioning group—0 (0 to 0), 0.05 (0 to 0.5); reserpine extinction-saline conditioning group—0.05 (0 to 0.5), 0.20 (0 to 0.5); saline extinction-reserpine conditioning group—1.75 (1.0 to 2.0), 1.70 (1.0 to 2.0); saline extinction-saline conditioning group—2.15 (1.8 to 2.5), 1.71 (1.0 to 2.5).

The first two columns of Table 2 give retention scores. The response of the animals that had had conditioning with saline was extinguished more slowly than the response of the animals that had had reserpine conditioning, regardless of which extinction drug was employed—this is presumably further evidence that the saline animals had learned more during the conditioning period. The reserpine extinction animals required more trials, on the average, to reach criterion than did the saline animals. Indeed, there is almost no overlap between the extinction subgroups. The reserpine group required slightly fewer trials, on the average, for extinction during the retention period than the total number of trials that the saline animals required during both the extinction and extinction retention periods (column 3).

Table 2. Extinction

Extinction drug	Extinction retention				Extinction	
	Reserpine (1)		Saline (2)		Reserpine	Saline
Conditioning drug	Reserpine	Saline	Reserpine	Saline	Reserpine	Saline
Trials	12	40	0	14	20	34
Trials	10	13	0	2	19	22

On the present evidence, the most parsimonious interpretation is in favor of reserpine's depressing temporarily both performance and learning—that is, that the drugged animals were functionally impervious to conditioning and extinction events, had to "start from scratch" once the drug had worn off, but subsequently responded normally to such events. Insofar as the reserpine groups, when tested after the gross effects of the drug had dissipated, differed from the controls in their rate of conditioning or extinction, they required more conditioning trials and fewer extinction trials, although these differences are far from being statistically significant. If, with a larger N or more refined technique, such differences were to become significant, explanation might follow one of several courses.

Examples of such possible explanations include the following: slight amounts of reserpine (or a metabolic product) might be active in the organism long after its gross effects had disappeared; in extinction, the reserpine animals have a longer time to "forget" the conditioned response, if they are impervious to the extinction events; the "baseline level of anxiety" might remain lower even after the drug has been completely metabolized.

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13 December 1955

New Theory of Interference in Clotting Mechanism by Abnormal Plasma Proteins

The present communication postulates a new type of defect in the clotting mechanism. This consists of the production by the body of globulins that have the ability to combine with and precipitate prothrombin and accessory factors from the blood plasma. The consequence is that the normal clotting mechanism is unbalanced. This results in the following changes: (i) a reduced concentration of clotting factors in the circulating blood, causing hemorrhages, and (ii), localized concentrations of prothrombin and accessory factors, causing thrombi.

Clotting defects, both hemorrhages and thromboses, are known to occur in association with clinical conditions in which abnormalities in the plasma globulins are well recognized, such as macroglobulinemia (1), multiple myeloma (2), purpura hyperglobulinemia (3), and cryofibrinogenemia (4). In addition, there exist clinical conditions such as carcinomatosis (pancreatic and so forth) (5), thrombophlebitis (5), pulmonary infarction, coronary occlusion, abdominal thrombosis, and postoperative thrombosis in which the causes of the thromboses have been the subject of investigation for many years without elucidation of their etiologies. Such cases now require reinvestigation in the light of our present theory.

This theory is based on the demonstration (6) that the precipitation of euglobulin, by dilution of plasma, takes out with it prothrombin and factor VII (stable factor). In one case (L. S.), the euglobulin consisted of macroglobulins with a major ultracentrifuge sedimentation component at $S_{20} = 20$ and two minor components at $S_{20} = >20$. In a second case (R. B.), euglobulin and cryoglobulin precipitates were obtained, both of which precipitated out prothrombin and accessory factors (factor VII), the euglobulin to a greater extent than the cryoglobulin. The euglobulin contained no macroglobulins, contrary to expectations. Both cases had increased plasma viscosity, which showed an anomalous rise with decreased temperature. Cryoprecipitability could be elicited in one case (R. B.) by freezing the plasma sample and in both cases by reducing the salt concentration of the sample. Macroglobulin precipitated under these conditions (L. S.) can be redissolved by the addition of albumin or minute traces of sodium carbonate but not by gamma globulin.

Both cases had hemorrhagic tendencies and reduced prothrombin activity. Case L. S. also had an extensive thrombus of the iliac vein. Precipitation of the euglobulins from both cases caused a marked reduction of both prothrombin and factor VII in the euglobulin-free plasma. The prothrombin and factor VII could be demonstrated in the solution of the precipitated globulins. The addition to and precipitation of macroglobulin from normal plasma removed prothrombin and factor VII from the normal plasma.

In addition to the afore-mentioned results, we have found that cold precipitable material is obtainable from normal and pathological plasmas. This material contains both fibrinogen and small amounts of prothrombin. Hence, the cold precipitation of fibrinogen takes down with it prothrombin. Studies of cryoglobulins are in progress. It is highly probable that prothrombin combines easily with many globulins in addition to

the accessory factors required in the clotting mechanism. The ease with which prothrombin is adsorbed by barium sulfate is well known. Slight changes in the plasma globulins that permit precipitation, therefore, would sequester prothrombin from the circulating plasma.

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6 February 1956

Pollen from Leda Clay of Maine

Marine clays of late glacial age occur widely in eastern Maine from below sea level to 400 ft or more above. These clays occasionally contain a well-preserved molluscan fauna of northern affinities, suggesting that, during the time of their deposition, the water was colder than it is at present. Because of the presence of species of *Leda*, these clays are frequently referred to as Leda clays, although their affinity is closer to the later *Saxicava* phase of the marine sediments in southeastern Canada.

One of the most productive fossil localities of the Leda clay in Maine occurs at Goose Cove on Mount Desert Island. The fauna from this locality has been described by Blaney and Loomis (1), who note that the assemblage has strong affinities with the present molluscan fauna of Labrador.

I had occasion to examine the clay from this locality for microfossils. The sample from which the analysis was made came from highly fossiliferous beds about 10 ft above high tide near the head of the cove. The microfossils were separated by a bromoform-acetone mixture (2) with a specific gravity of 2.3. A large number of pollen grains and spores, together with some marine and brackish-water sponge spicules and a few Foraminifera, were recovered. Table 1 shows the result of the pollen-spore analysis.

The pollen content of the clay is very similar to the pollen assemblages that I found in late glacial clays of southeastern New England, but it differs in several

respects from the pollen flora of the interstadial clays and clay tills of the Cape Cod area (3).

The exact age of the Leda clay is still unknown. Although there is evidence that glacial ice still existed in the vicinity when the clay was deposited, the fauna is by no means arctic in character. Studies of lake and peat deposits in this region by Deevey (4) and me (5) indicate that the marine submergence occurred previous to Zone A1 of Deevey's late-glacial pollen chronology.

According to this chronology, widespread tundra conditions prevailed in southeastern Maine and possibly as far south as Connecticut in late glacial time. However, my pollen studies of late glacial clays from eastern New England do not indicate that such conditions existed during the time of deposition. Pollen grains from plants that are common in a tundra or semitundra environment are lacking or are very rare. Furthermore, the total nontree pollen, including spores, is very low compared with the total tree pollen, a condition just opposite to that which occurs in tundra areas. The great number of tree pollens, especially those having a relatively high rate of fall, precludes the possibility of their having been transported by wind any great distance.

The possibility that the pollen grains in the clay from Goose Cove are secondary seems unlikely for several reasons. (i) There are no known interglacial or older deposits in Maine from which the pollen grains could have come. (ii) The unusual abundance of the pollens at Goose Cove and the lack of other plant remains indicate that the plant microfossils have not come from reworked pollen-bearing deposits in the vicinity. (iii) I have examined a large number of other samples of Leda clay and till from eastern Maine for microfossils without success. This absence of pollens elsewhere, together with their localized occurrence at Goose Cove, also indicates that these microfossils are indigenous to the Leda clay of Mount Desert Island.

A comparison of the pollen analysis of the clay from Mount Desert Island with the analyses by Wenner (6) of surface samples from the barren and wooded areas of Labrador shows a close similarity to the assemblages found in the forest area of southern Labrador. In this area, the pollens of birch, alder, willow, heath, and sedge—plants commonly found in the tundra areas farther north—are relatively rare, while the pollen grains of conifers are extremely high, as in the Leda clay of Maine.

Evidence that the eastern part of Maine was at least partly forested during the late glacial marine phase is given by Berry (7), who identified some fossil plants in the lower portion of shell-bearing Leda clays near Waterville (8).

Table 1. Pollen grains and spores found in Leda clay from Goose Cove, Mount Desert Island, Me.

Species	Percentage
<i>Picea</i> (spruce)	51
<i>Pinus</i> (pine)	28
<i>Abies</i> (fir)	7
<i>Ulmus</i> (elm)	1
<i>Quercus</i> (oak)	1
<i>Tsuga</i> (hemlock)	trace
Rosaceae cf. (rose family)	1
Gramineae (grass)	7
Fern spores	2
Spores (undifferentiated)	2

Among the plants identified were the leaves of balsam poplar (*Populus balsamifera*), which was the only plant found that has strictly northern affinities. This tree is now distributed from the forest area of Labrador south to northern New England. The rest of the plants identified are shrubs that have a more southern distribution and are also common in Maine at the present time. On the basis of these plant remains, Berry came to the conclusion that, during the marine submergence, the climate of southeastern Maine was similar to that of today.

Thus, from the evidence of the fossil plants and pollen, it seems probable that extensive forest growth existed in eastern Maine during the marine submergence in late glacial time and that the climate, as deduced from the flora of the clays, was at least as warm as that of southern Labrador today.

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2 February 1956

Two Obscure Oyster Enemies in New England Waters

The American oyster, *Crassostrea virginica* (Gmelin), like many other pelecypod mollusks, is attacked by numerous enemies. Of these, the common starfish, *Asterias forbesi* (Desor), and two species of drills, *Urosalpinx cinerea* (Say) and *Euploea caudata* (Say), are best known. Certain other enemies, perhaps because they are less striking in appearance, are

comparatively small or, because they are not easily observed, are little studied and their activities are virtually unknown. This is true of the two forms which I have been recently observing in New England waters and which may be responsible for several "mysterious" mortalities of oysters, especially the young. One of these enemies is a flatworm and the other is a gastropod.

The worm is the polyclad, *Stylochus ellipticus* (Girard), identified by Libbie H. Hyman of the U.S. National Museum. It is usually found among oysters and old shells, on barnacles, and under rocks. Although the biology and destructiveness of the closely related species, *Stylochus inimicus* (Palombi), the so-called oyster "leech" of southern waters, have been extensively studied by several investigators, including Pearse and Wharton (1), very little is known of many aspects of the biology of *S. ellipticus* of New England waters, and the extent of its predation on our oysters has never been systematically observed or accurately estimated.

Our recent studies suggest that *S. ellipticus* plays a rather important role in the destruction of oysters, especially young ones. Laboratory observations have shown that the worms have little difficulty in entering and killing spat, even those measuring more than 2.5 in. in length. In one experiment, when ten worms were placed in the same dish with 30 healthy spat averaging about 1.7 cm in length, the worms killed 21 spat in less than a month. Not a single spat died in the control tray during that period. On at least two occasions, we saw the worms entering slightly open oysters. A day or two later, these oysters were gaping and soon died. A single worm was found in one oyster, and in the second, three worms were feeding on the oyster meat.

Since *S. ellipticus* has been found in comparatively large numbers in many areas where oysters grow, it, no doubt, can present an important problem. This contention is supported by Woelke's (2) finding that a closely related form, *Pseudostylochus* sp., causes extremely heavy mortality among three species of oysters grown on our Pacific Coast. Obviously, to gain the necessary information on the destructiveness of *S. ellipticus* and to devise methods for its control, more extensive studies of its life-history and ecological requirements are imperative.

The second enemy is a small gastropod, which was identified by Fritz Haas of the Chicago Natural History Museum as *Menestho* (*Menestho*) *bisuturalis* (Say). By some experts this gastropod is still placed within the genus *Odostomia*. It is a small, whitish snail that seldom reaches the size of 5.0 mm and is often found in shallow water. It belongs to the family Pyramidellidae. Fretter and Graham (3),

who studied the snail's feeding apparatus in detail and also the mode of life of this group, report: "Pyramidellids are ectoparasites. Each species feeds on a particular species of host, usually a tubicolous polychaete or a lamellibranch mollusc, obtaining attachment to the body by means of the oral sucker, piercing the body wall with the buccal stylet and sucking blood, and perhaps tissue debris, by means of the buccal pump." These authors also gave a list of the hosts that have been found to be attacked by the members of the Pyramidellidae family. More recently, Cole and Hancock (4) added to this list *Odostomia eulimoides* (Hanley) and *Chrysallida obtusa* (Brown), which they found caused serious damage to the European oyster, *Ostrea edulis* L. Another pyramidellid was found by Medcof (5) to be attached to the siphons of *Mya arenaria* L. Medcof, however, thought that because it had no radula, it was commensal and not a predator.

Recently, I have been observing under laboratory conditions the behavior of *M. bisuturalis* in relation to young American oysters and found that it resembles the behavior described by Fretter and Graham for other Pyramidellidae. The typical feeding position of this snail is along the edges of the oyster shell, to which it attaches itself by the oral sucker. We have often seen groups of these snails occupying such a position on a single oyster. When the shells are open the snails protrude their proboscis to reach the soft parts of the oyster, usually the edge of the mantle. At first the oyster reacts to this stimulus by closing its shells but, apparently, it soon becomes accustomed to it and remains open, even if several *M. bisuturalis* are touching its mantle with their proboscis. In this respect the behavior of the oyster resembles, to a large extent, the reaction of other invertebrates attacked by related species of pyramidellids (3).

I found *M. bisuturalis* in large numbers on young oysters, especially those that came from shallow water areas. Although these snails may not be very successful in killing the oysters after the latter reach the size of about 1.0 cm, they, no doubt, interfere with the oysters' normal development and growth. This is often shown by the characteristically deformed shells of the young oysters that came from areas heavily infested with *M. bisuturalis*. The shells, instead of being flat, which is normal for shells of young oysters that are not too crowded, are deeply cupped and may have thickened edges. This abnormality is apparently due to injuries caused, by the activities of *M. bisuturalis*, to the edges of the oyster mantle, the organ that secretes the shell.

As in the case of *S. ellipticus*, it is ap-

parent that we need more information on the feeding habits and general ecological requirements of *M. bisuturalis* before estimating its destructiveness and devising methods for its control.

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10 February 1956

Collection of Atomic Bomb Debris from the Atmosphere by Impaction on Screens

Some of the theoretical factors (1) which determine the efficiency of collection of aerosol particles on fibers in a moving air stream are inertia and interception, electrostatic attraction, gravity settling, Brownian diffusion, and thermal forces.

Radioactive particles having a wide range of sizes are produced in an atomic explosion and carried to high altitudes in the fireball. Gravity operates to modify the original particle-size distribution, so that, after a few days, particles in the micron range predominate at ground level. For particles of this size, electric attraction and inertial effects are the most important factors in the deposition process.

Preliminary work with charged wires showed that for fission-product activity, the inertial effect was predominant. The efficiency of collection depends on the extent to which particles approaching a wire or fiber will strike it and become attached instead of following the streamlines of air flow. Theoretical efficiencies of at least a few percent are predicted for the wire diameters, particle sizes, and air velocities of concern in our experiments (1).

During the atomic tests held in Nevada during the fall of 1951 and the spring of 1955, metal screens of various mesh sizes were exposed at Washington, D.C., on a vane arrangement as shown in Fig. 1. The collected radioactivity was removed from the screen by repeated washing with acetone and nitric acid. The wash liquid was evaporated to dryness, and the residue was counted by standard beta-counting techniques. Chemical separation of individual isotopes followed by decay measurements

identified the material as recently produced fission products.

Table 1 compares the activity (beta counts per minute corrected for geometry) of weekly collections made at Washington, D.C., during early 1955 with (i) an 80-mesh stainless steel screen, (ii) an efficient filter apparatus (capacity 30 ft³/min) and (iii) the standard gummed-paper fallout technique (2). The total activity collected by the screen in 1 week was roughly comparable to that of a filter collection of approximately 3×10^5 ft³ of air and, in some cases, was as much as 100 times that deposited on an equal horizontal area by fallout. As determined from the estimated air flow and the amount of activity collected, the screen is about 1-percent efficient in the absence of rain. Since a strong dependence of fallout on rain has been observed, and since there are indications that precipitation will wash activity from the screen, figures for the total precipitation have been included in Table 1.

Comparative measurements of 1-week collections were made, using electrically grounded screens of 40, 60, 80, and 200 mesh. During the period of observation, the amount of activity collected did not vary in a regular way with mesh size. It is possible that the increase in collecting area obtained with the smaller mesh sizes was compensated by the reduced air flow. In a single comparison between grounded and well-insulated screens, the amount of radioactivity collected was not affected appreciably, although the weight of solid matter in the residue was nearly doubled in the case of the insulated screen.

Ordinary cheesecloth (3) (about 40 mesh) can be used in place of metal screens and seems to lose less activity during rain. It has the advantage that it may be ignited and the ash counted directly in the same manner as the gummed papers. Flags made of cheesecloth also collect fission-product activity, but with only about one-tenth of the efficiency of the vane-mounted cloth.



Fig. 1. Rotating vane for holding collecting screens.

Table 1. Comparison of simultaneous filter, gummed-paper, and screen collections.

Date of collection (1955)	Filter collector (disintegration/min)	Gummed paper (disintegration/min)	Stainless steel screen (disintegration/min)	Rainfall (in.)
21-28 Feb.	8,400	340	3,100	1.22 (snow)
28 Feb.-7 Mar.	2,500	200	2,100	1.78
7-14 Mar.	4,900	92	3,400	0.15
14-21 Mar.	5,200	5,100	1,700	1.13
21-28 Mar.	7,500	2,000	11,000	0.43
28 Mar.-4 Apr.	6,700	64	7,700	0
4-11 Apr.	8,000	320	3,800	0.07
11-18 Apr.	14,000	130,000	75,000	1.50
18-25 Apr.	8,900	2,300	1,500	0.47
25 Apr.-2 May	2,000	700	1,900	0.40
2-9 May	9,800	31,000	14,000	0.01
9-16 May	9,300	5,500	2,600	1.62
16-23 May	10,000	9,700	4,700	0.50
23-31 May	110,000	13,000	24,000*	1.11
Total	207,000	200,000	157,000	

* Cloth screen.

During the 2-month period of maximum fallout in the spring of 1955, daily samples of 1-ft² cloth screen gave a total fission-product collection of 2.8×10^5 beta disintegrations per minute as compared with 1.8×10^5 disintegrations per minute using the filter device and 1.9×10^6 disintegrations per minute on standard 1-ft² gummed papers.

In order to get some idea of the efficiency of the screen collector, a composite filter was made up of 7-in. squares of 40-mesh nickel screen on top of 100-mesh copper screen and backed by an efficient filter paper. Air was drawn through this filter at a face velocity of 3000 ft/min by a blower. A rough measure of the efficiencies of the screen filters was obtained from the relative amounts of the cerium-144 (praseodymium-144) isotope deposited on the different filter components. Particle retentions on the screens were compared by assuming that the filter paper was 100-percent efficient. The 40-mesh nickel screen at the top retained 11 percent of the total radioactivity, and the 100-mesh copper screen retained 18 percent, giving a total retention on both screens of 29 percent.

Direct impaction on small fibers is an effective mechanism for deposition of the radioactive particulate matter produced by atomic bombs. While even at highflow rates the collection efficiency of screens is comparatively low, their low air-flow resistance and tendency to discriminate against the extremely small particles comprising the natural activities may be advantageous where simple detection of air-borne, fission-product radioactivity is the sole consideration.

Natural filters such as grass or trees may behave like many layers of filter fibers in removing activity carried by surface winds. In this case, the removal of particulates is fairly efficient and may

account for a large fraction of the fission-product activity deposited on vegetation, particularly in the absence of precipitation.

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19 January 1956

Bonding in the Molecular Addition Complexes of the Alkyl Phosphates and Thiophosphates

In connection with a recent study involving the determination of the solubilities of certain inorganic metal nitrates in the trialkyl phosphates and thiophosphates (1), a great difference was observed in the solubilities of the salts in these two solvents. Since the dielectric constants for the two solvents are similar (2), the difference in solubility must be due to the difference in bonding between the metal salts and the organic molecules.

To elucidate the nature of this bonding, the solubility of uranium (VI) nitrate hexahydrate, thorium nitrate tetrahydrate, and copper (II) nitrate hexahydrate were determined in tri-n-butyl phosphate (TBP) and tri-n-butyl thiophosphate (TBPS) (3). These two compounds are alike in structure, except

that the TBP has a semipolar P \rightarrow O bond, while the TBPS has a semipolar P \rightarrow S bond.

The procedure for the solubility determinations consisted of adding about 25 g of the solid salt to 20 ml of the pure solvent contained in a 50-ml bottle, sealing the bottle, and equilibrating the contents on a mechanical shaker for 48 hours at room temperature (25 to 27°C). It was found that this was sufficient time for equilibrium conditions to be established. At the end of this time, three phases were present in the bottle—a solid hydrated-salt phase, an aqueous phase containing a saturated solution of the metal salt, and an organic phase. The organic phase was separated, centrifuged, and analyzed for metal content.

The analysis consisted of weighing out 1- to 4-g duplicate samples of the centrifuged organic phase into separatory funnels containing 25 ml of benzene and 50 ml of water. After equilibration for 2 minutes, the aqueous phase was separated, 50 ml of water was added, and the equilibration was repeated. Two such extractions were sufficient to remove the metal salt from the organic phase. The metal content in the extracted aqueous phases was determined as follows: uranium by the 8-quinolinol method (4), thorium by the oxalate method (5), and copper by the cupferron method (6).

The solubilities of the metal nitrates are given in Table 1. In the TBP, it can be seen that uranium (VI) nitrate is the most soluble. Thorium nitrate is only slightly less soluble than the uranium salt, while copper (II) nitrate is about half as soluble as the other two. The striking observation is that the metal nitrates are only about one-twentieth as soluble in the TBPS as they are in the TBP.

The solubility of uranium (VI) nitrate in TBP has been attributed to the formation of the molecular addition complex, $[\text{UO}_2(\text{TBP})_2(\text{NO}_3)_2]$ (7). The solubilities of the other metal nitrates can also be attributed to this effect but as yet have not been investigated.

The decreased solubilities of the metal

Table 1. Solubilities of the metal nitrates in tributyl phosphate and tributyl thiophosphate at room temperature (25-27°C). The solubilities are expressed in grams of anhydrous metal nitrate per 100 g of solution.

Metal nitrate	TBP	TBPS
$\text{Th}(\text{NO}_3)_4 \cdot 4\text{H}_2\text{O}$	42.6 ± 0.2	2.1 ± 0.2
	42.4	1.8
$\text{UO}_2(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	43.6 ± 0.2	1.8 ± 0.2
	43.4	2.3
$\text{Cu}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	21.5 ± 0.1	0.62 ± 0.05
	21.3	0.51

nitrate salts in TBPS, as compared with TBP, suggest that the organic molecules are bonded to the metal-nitrate salts in a different manner. Since the only differences in structure in the two organic molecules are the semipolar bonds, $P \rightarrow O$ and $P \rightarrow S$, this would indicate that the interaction involves these atoms with the metal-nitrate salts to form a complex. If the metal-nitrate salt were bonded to the organic molecules through the alkyl oxygen atoms alone, one would not expect any difference in the solubilities of the salts in the two solvents. Exactly how many atoms of the organic molecules are involved in the bonding to the metal-nitrate salts is not known. It is possible that the bonding may involve the semipolar atoms in each of the organic molecules as well as the alkyl oxygen atoms.

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9 January 1956

Serum Lactic Dehydrogenase Activity in Acute Transmural Myocardial Infarction

During experimental and clinical transmural myocardial infarction, glutamic oxaloacetic transaminase is released from cardiac muscle; this results in increased enzyme activity in the serum (1). This fact suggested that other enzymes in cardiac tissue might act similarly during myocardial infarction (2). Table 1 lists the activities of lactic dehydrogenase (LD) in dog tissue homogenates. Although the activity in the heart is less than the activity in the kidney, skeletal muscle, and liver, it is reasonable to expect LD to be released into the serum following damage to heart muscle.

The presence of LD in animal and in human-blood serum and whole-blood hemolysates was previously demonstrated in our laboratory by spectrophotometric assay (3). The chemical characteristics of the enzyme in serum were studied and found to be similar to those reported for

Table 1. Estimated lactic dehydrogenase activity of tissues of the dog.

Tissue	Activity (units/g of wet tissue)
Kidney	640,000
Skeletal muscle	600,000
Liver	390,000
Heart	240,000
Pancreas	150,000
Spleen	140,000
Brain	130,000
Lung	25,000

animal tissues. The normal range of activity in human serum and hemolysates was established. The level was found to be elevated in certain disease states but notably in patients with acute and chronic leukemia, generalized carcinomatosis, and acute transmural myocardial infarction.

Serum lactic dehydrogenase was measured by adding serum to a substrate containing pyruvic acid, which oxidizes DPNH to DPN. The resulting change in optical density of the solution was measured in a Beckman DU spectrophotometer (3). The unit of serum LD is defined as the enzyme activity present in 1.0 ml of serum that causes an optical density decrease of 0.001 at a wavelength of 340 m μ in 1 minute under the conditions described. Determinations were made at 23°C. In 243 normal individuals, the range was between 200 and 680 units with a mean of 440 ± 120 . The range of serum activity in the normal dog is comparable to the range of activity of human serum.

Serum lactic dehydrogenase was measured in the following: 243 normal individuals, 30 patients with cardiovascular disease that was uncomplicated by acute infarction, 35 with leukemia and malignant lymphoma, 10 with generalized carcinomatosis, 50 with localized carcinoma and other neoplastic disease, 30 with various infectious diseases, and 13 with acute transmural myocardial infarction. Venous blood was obtained for serum-LD determination regardless of the fasting state. The serum was separated from the clotted blood within a period of 2 to 24 hours after collection. It has been found that the activity is essentially unchanged if the separated serum is stored in a refrigerator from 1 to 3 days after collection. When possible, daily bleedings were made during a 5- to 10-day period.

Figure 1 summarizes the serum-LD activity on various days after infarction in 13 patients who had acute transmural myocardial infarction. Figure 2 shows the serum-LD activity during a 9-day period in a 58-year-old patient who incurred an acute, transmural, anterior-wall myocardial in-

farct. The LD activity was 1480 units within 48 hours and gradually fell to normal by the sixth day. The alterations in serum-LD activity in a dog, following closed-chest-wall experimental coronary-artery ligation that resulted in myocardial infarction, are comparable to the alterations seen in human infarction.

In 30 patients with heart disease, including arteriosclerotic heart disease that was associated with coronary insufficiency and/or acute and chronic congestive heart failure but that was not complicated by acute myocardial infarction, the serum-LD activity varied from 300 to 1020 units. In two of these patients, the serum-LD activity was above 680 units/ml. In one of these, chronic heart failure was present in a patient with hypertensive heart disease, auricular fibrillation, and polycystic kidney disease. The second patient had arteriosclerotic heart disease with heart failure.

All patients studied who had acute febrile and chronic infectious diseases had serum-LD activities within the normal range. Normal values were also encountered in anemia, pulmonary infarction, localized neoplastic disease, and chronic disease processes. High levels were encountered in patients with acute and chronic leukemia in relapse, generalized carcinomatosis, and, occasionally, acute hepatitis during its clinical peak, but not in patients with jaundice due to other causes. The serial LD-activity alterations that were noted following myocardial infarction have not been encountered in other clinical settings.

Our observations show that serum-LD activity rises within 24 hours in experimental and human myocardial infarction and returns to the normal range within 48 hours in dogs and within 5 to 6 days in human beings. The mechanism by which the level of enzyme activity is altered is under study but is pre-

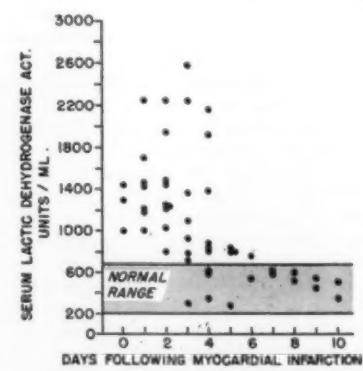


Fig. 1. Serum lactic dehydrogenase activity during the first 10 days following acute transmural myocardial infarction in 13 patients.

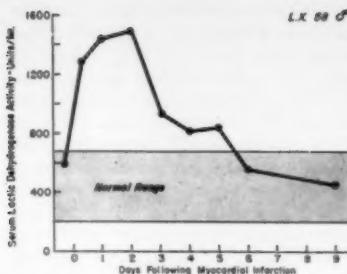


Fig. 2. Serum lactic dehydrogenase activity at the onset of chest pain and during a 10-day period following acute myocardial infarction in patient S.X.

sumed to be the result of the release of the enzyme from the infarcted heart disease. The limited number of cases presented does not permit final evaluation of these observations with regard to either their diagnostic or prognostic significance.

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19 January 1956

Crosslinking of Latex Rubber

Most of the properties of rubber are consistent with those expected of a high-molecular-weight linear polymer of isoprene. However, there are some features of its behavior that are inexplicable on this basis. They must be the result of the presence of small amounts of structures other than the regular head-to-tail chain of isoprene units.

Bloomfield, in the first fundamental study (1) of the properties of rubber from freshly tapped latex, found that the tree does not continue to build indefinitely a linear polymer, but that branching reactions occur in a rested tree. These reactions eventually convert individual latex particles into substantially single molecules of enormous molecular weight. Bloomfield also observed that small amounts of oxygen are intimately associated with the hydrocarbon, even when

it is isolated directly from the tree with careful exclusion of atmospheric oxygen. Craig, Juve, and Davidson (2) have found less certain indications of the presence of carboxyl groups, which, if they are present in the rubber in concentrations even approaching the amount indicated by their results, must be on side chains.

Watson (3) discovered evidence for unique links in the hydrocarbon chain at intervals of about 700,000 in molecular weight; these links dissociate at a measurable rate in solution. He has suggested that these links may be responsible for the slow "gelation" of massive rubber. Messenger (4) showed that this reaction is inhibited by water: samples stored in the presence of desiccants progressively increased in molecular weight (actually in solution viscosity) and finally became increasingly insoluble in the usual rubber solvents. This has recently been substantiated by further work by Wood (5) in connection with the "Technically Classified" rubber program (6).

A less well known phenomenon, although it is familiar to users of commercial latex, is the rapid development of high viscosity and relative insolubility in rubber that is obtained from preserved latex. Such rubber may become as high as 80-percent insoluble in benzene and have "Mooney" viscosities (7) of more than 100.

During the period 1948-50, the Plantations Division of the United States Rubber Company imported a number of samples of latex that had been preserved in a variety of ways, in the course of an intensive study of preservation methods. As a result, it was possible to obtain (8) data which indicate that the preservative used has a specific effect on the viscosity of the rubber (Table 1). Among other tests on the latexes, the solubility in benzene and the Mooney viscosity (ML4-212) of the rubber obtained by drying samples of the latex at room temperature were measured. Solubility was determined by the conventional procedure (developed for GR-S) in which 0.5 g of rubber supported on steel screens is left in contact with 75 ml of solvent for 24 hours in the dark, after which the concentration of an aliquot of the solution is determined.

There were not available enough high pH latexes containing no ammonia to eliminate entirely pH as a factor, but only those latexes containing free ammonia have the combination of Mooney viscosity greater than 100 and percentage gel greater than 30, indicating strongly that ammonia has a specific effect in increasing the extent of crosslinking in the latex rubber.

This is a positive effect—that is, it does not result from inhibition of degradation

Table 1. Effect of preservative on gel and viscosity.

Latex No.	pH	Ammonia*	Other amine†	Gel (%)	ML4-212
63	11.3	—	—	0	99
47	10.4	+	—	59	118
48	10.4	+	—	58	111
66	10.4	+	—	60	> 110
68	10.4	—	+	30	98
72	10.3	+	—	65	> 110
73	10.3	+	—	49	103
57	10.3	+	—	52	108
35	10.3	+	—	58	111
40	10.2	—	+	16	87
74	9.8	+	—	39	> 110
157	9.7	—	+	12	67
58	9.6	—	+	12	64
37	9.4	—	+	18	71
38	9.4	—	+	7	64
64	9.4	—	+	12	63
62	9.3	—	+	12	72
67	9.2	—	+	9	79
60	9.1	—	+	13	84
75	8.9	—	+	9	76
27	8.7	—	+	29	70
23	8.5	—	+	8	65
61	8.5	—	+	12	76
24	7.2	—	+	17	
39	6.9	—	+	15	77
12	6.6	—	+	15	84
1	5.8	—	—	18	75

* —, preservative absent; +, present.

† Amines other than ammonia were all low-molecular-weight aliphatic amines. Dimethylamine was the sole preservative in latex 68.

by oxygen during storage and handling of the latex. The rate of reaction of oxygen with latex is highest in the range of pH of commercial latex, and it falls sharply when the pH is less than 9 (9). The rubber from fresh latex from trees tapped regularly is usually soluble, and its Mooney viscosity is in the range of 60 to 80. Further, the viscosity increase can be induced in latexes that have been preserved without ammonia.

Small amounts of several of the low pH latexes listed in Table 1 were treated with ammonia (2 percent) and left standing for 6 months. The rubber in all these samples increased markedly in viscosity as compared with controls (Table 2).

It appears quite possible that the same functional groups are responsible for the crosslinking induced by ammonia and that which occurs during storage of dry rubber. During the development of the USF rubber process (10) C. E. Linscott observed that brief treatment with ammonia of the latex or of freshly precipi-

Table 2. Effect of ammonia on low pH latexes.

Latex	ML4-212 after 6 months	
	Control	Ammonia added
24	90	105
39	85	114
40	87	107
60	78	108
62	78	102

tated rubber from formaldehyde-preserved latex caused an immediate rise in Mooney viscosity and accelerated the later slow rise in viscosity during storage of the dry rubber.

The fragility of the swollen gel makes it difficult to determine precisely the volume ratio of solvent to rubber. Molecular weights between crosslinks (11) estimated from the figures available range from $\sim 5 \times 10^6$ for the samples with higher gel contents to more than 10^6 for the very tenuous gels frequently obtained from samples with low gel. The maximum observed extent of crosslinking is thus in reasonable accord with Watson's estimate of the concentration of unique linkages in rubber.

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Biological Origin of Native Sulfur in Salt Domes of Texas and Louisiana

Elemental sulfur in the cap rock of the Gulf Coast salt domes is crystalline, and it fills fractures and replaces wall rock of the porous calcite cap rock (1). Its origin is commonly thought to have been reduction of the sulfate, gypsum, and anhydrite of the cap rock with the formation of hydrogen sulfide, which became oxidized to elemental sulfur (2).

Although sulfate is reduced to sulfide by methane and other organic compounds at high temperatures (700° to 1000°C), there is evidence that the temperature in the salt domes has not exceeded 100°C . Tests were made of the chemical reduction of sulfate by organic compounds (3). Samples of salt-dome crude oil and methane were mixed with solutions saturated with calcium sulfate from cap-rock

samples. Carbonate and sodium chloride, as well as iron sulfide, were added in some of the experiments. At temperatures between 40°C and 100°C , no hydrogen sulfide was produced in tests that lasted several months. This suggested that nonbiological reactions were not instrumental in the reduction of sulfate to sulfide in the salt domes.

Sulfate-reducing bacteria have been detected in the formation waters issuing at the ground surface and in drill cores (4), and it has been suggested that these bacteria converted the sulfate to sulfide, the initial transformations of the reactions that resulted in deposition of elemental sulfur. This hypothesis is supported by evidence of Thode, Kleerkoper, and McElcheran (5) of the fractionation of the stable sulfur isotopes S^{32} and S^{34} during bacterial reduction of sulfate to sulfide. The sulfide was richer in S^{32} than the sulfate from which it originated. The percentage fractionation F was calculated as follows:

$$F = 100 \times \frac{\text{S}^{32}/\text{S}^{34} \text{ of product} - \text{S}^{32}/\text{S}^{34} \text{ of reactant}}{\text{S}^{32}/\text{S}^{34} \text{ of reactant}}$$

F was found to be 1.1 percent in experiments carried out at 25°C , where the product was sulfide and the reactant was sulfate.

Thode, Wanless, and Wallouch (6) found that the sulfide and elemental sulfur of Texas and Louisiana sulfur deposits have higher ratios $\text{S}^{32}/\text{S}^{34}$ than associated sulfate, indicating enrichment in S^{32} during their formation from sulfate. Tests on ten Gulf Coast salt domes showed percentage fractionations of 4.6 percent for the sulfide sulfur and 3.9 percent for the elemental sulfur.

Laboratory studies were made of the amount of fractionation of the sulfur isotopes resulting from reduction of sulfate to sulfide by the sulfate-reducing bacterium, *Desulfovibrio desulfuricans*. The bacteria were cultivated in a 5-lit fermentor in which the medium was continuously agitated to prevent local variations in sulfate concentration. Determinations of the $\text{S}^{32}/\text{S}^{34}$ ratios of the sulfate used to prepare the medium and of the sulfide produced from sulfate by the bacteria were made by means of a dual collector mass spectrometer. During bacterial growth the sulfide was collected from a stream of nitrogen gas that was passed through the substrate, and determinations were made on the sulfide recovered at various incubation periods.

The amount of fractionation varied from negligible values to a maximum of 2.7 percent, and it was affected by factors that influence the rate of bacterial development and by the concentration of sulfate. The slower the growth, the greater was the ratio $\text{S}^{32}/\text{S}^{34}$ of the sulfide, indicating enrichment in S^{32} during

reduction of sulfate to sulfide. Fractionation was greatest when the incubation temperature was low (10° to 20°C), when the concentration of soluble sulfate was high, and when only a small portion of the total sulfate became reduced. There should be still greater fractionation than that noted when the rate of bacterial reduction of sulfate is slower than it was under the experimental conditions used.

The source of energy for development of the bacteria in the salt domes is still uncertain. Some components of crude oil may have been utilized, for it has been reported (7) that the bacteria can develop on crude oil, and additional positive results have been obtained in preliminary experiments in our laboratories.

Although it is likely that the oxidation of sulfide to elemental sulfur was non-biological, it is improbable that it was due to reaction with oxygen, for the oxygen content of salt-dome waters is negligible.

The reaction rate between hydrogen sulfide and calcium sulfate in laboratory experiments was sufficiently rapid so that it may be assumed that this sulfide-sulfate reaction produced the elemental sulfur of the salt domes. The fact that the elemental sulfur in the formations has a ratio of $\text{S}^{32}/\text{S}^{34}$ that is intermediate between the ratios of the sulfate and hydrogen sulfide of the liquid phase supports this hypothesis.

The composition and environmental conditions of the salt-dome formations and the results of the laboratory investigations indicate that sulfate-reducing bacteria played an important role in the formation of the sulfur in the deposits. These bacteria probably reduced dissolved sulfate to hydrogen sulfide. The subsequent formation of elemental sulfur was most likely due to a nonbiological process such as a reaction between sulfide and sulfate.

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Radiosensitivity Factors in Oat Seeds: Dormancy, Water, and Development

Germinating seeds have been reported to be more sensitive to irradiation and to have exhibited higher mutation frequencies than dormant seeds (1). This has been variously related to three major factors—namely, water content (high or low), actively growing tissue, and mitotic activities (2). The role of each factor has been difficult to evaluate because the factors are interdependent and function together in processes of growth. The study described here (3) attempted a comparative experimental test in which one factor played its role as an independent variable and in which the other two were held constant as far as this could be accomplished with living biological entities.

Radiosensitivities of two lots of seed were compared. Both lots were of the same stock and were in dormant state, with moisture content approximately equal. One differed from the other chiefly in the structural and other developments, including those of nuclei, brought about by a period of preactivation or partial germination. One lot was ungerminated and dormant, with 13.1 percent moisture. The other was partially germinated and dormant; it was prepared by soaking ungerminated seeds in running water for 20 hours at 29°C (4), then air-drying to 12.6 percent moisture to return them to dormancy. These seeds became 7.5 percent larger but slightly lighter than the ungerminated seeds.

Germination of both lots prior to irradiation was normal, and the percentage germination was equal (95.1), indicating that activation and subsequent desiccation did not alter adversely viability or vigor.

The irradiations were in replications with x-rays (25,000 r) and with thermal neutrons for 6 hours (flux $6.2 \times 10^8 N_{th}/cm^2 \text{ sec.}$) (5).

Irradiation effects were measured in the laboratory by germinating the seeds under uniform conditions of temperature and moisture and then recording inhibition and stunting of both roots and shoots (leaves and coleoptiles) after 7 days. Lethal effects were judged by the number of nongerminating seeds in excess of that for the checks; inhibition and stunting were judged by reduction in number and length of radicles, by absence of shoots, and by length of shoots. Three replicated trials at room temperature and one at constant temperature of 20°C gave similar results (2400 irradiated seeds and 1200 nonirradiated checks were studied with a total of 72 replications of 50 seeds each).

Additional seed lots were soaked in 2-percent NaCl for 2 hours immediately after water-soaking and prior to desiccation and irradiation. The results (Table 1) were as follows.

1) Partially germinated dormant seeds exhibited greater sensitivity to both x-rays and thermal neutrons than ungerminated seeds of comparable moisture content. The average seedling size of x-rayed, partially germinated seeds was 15.4 percent of normal, whereas that of ungerminated was 34.5 percent of normal. The greatest lethal effects were caused by x-rays on partially germinated seeds.

2) Radiation effects of x-rays were greater than those of thermal neutrons (for the doses used) for both seed lots, as has been previously reported for germinating seeds.

3) Roots suffered greater inhibition from irradiation than leaves. In partially germinated seeds, they were shorter than the leaves, while in the ungerminated checks the reverse was true. This differ-

ence in response of the two main organs may be attributed either to inherent cell differences in radiosensitivity or, more probably, to the more advanced development of the roots, indicating that even slight differences in growth rates may be reflected in marked differences in radiosensitivity.

4) Both irradiated and nonirradiated populations showed great variability in rate of development and size of roots and leaves. This variability, as statistically expressed by a coefficient of variability (percentage), seems to be correlated with the amount of injury sustained by each irradiated population, as follows: x-rayed, partially germinated, 115 percent; x-rayed, ungerminated, 75 percent; thermal-neutron treated, 42 percent (non-irradiated, 36 percent). The coefficient of variability for all irradiated radicles was 92 percent; for all irradiated shoots, 64 percent.

Within nonirradiated seeds, root elongation during the first 48 hours ranged from 0 to 8 mm. Roots developed twice as fast as shoots in the early hours of germination. These differences may account for the difference in radiation effects within a given population. Activated, salt-treated seeds showed less injury than nontreated seeds, possibly because the diffusing salt, upon reaching the embryo, slowed down germination (6).

It may be concluded, therefore, that the increased radiosensitivity of partially germinated, dormant seeds over ungerminated seeds was induced by a factor or factors other than moisture content. Germination induces the synthesis of many enzyme systems, and it is assumed that the partially germinated dormant seeds had a higher enzyme complement than the ungerminated seeds. However, at the time of irradiation the enzyme activities of both kinds of seed were at their minimum, because of the low moisture content

Table 1. Effects of irradiation on ungerminated and partially germinated, dormant oat seeds. (Germination for 7 days at 20°C.)

Kinds of dormant seeds and irradiations	Non-germinating seeds after irradiation (%)	Shoots		Radicles	
		Seedlings with no radicles (%)	Average length (mm)	Standard error	Average length (mm)
Partially germinated, x-rays	12	12	8	0.8	6
Ungerminated, x-rays	8	3	20	0.9	15
Partially germinated, thermal neutrons	7	1	35	0.8	20
Ungerminated, thermal neutrons	7	1	48	1.1	26
Partially germinated, no irradiation	5	0	56	1.2	67
Ungerminated, no irradiation	5	0	53	1.4	64

* Seedlings with shoots only, the radicles having been completely inhibited.

and the cessation of all growth. The increased radiosensitivity appears to be chiefly associated, then, with the advanced developments induced in the partially germinated, dormant seeds. These developments may be identified with certain chemical and structural changes within rapidly dividing cells—namely, the initiation of nuclear divisions and the exposure to irradiation of enlarged and possibly oversensitized chromosomes, just prior to, or during mitotic activities.

Inasmuch as the water content of both lots of seeds was about the same, it would seem that increased seedling injury in the case of partially germinated, dormant seeds is related primarily to direct absorption of energy from ionizing radiations rather than to indirect chemical action of active radicles produced in the presence of water.

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Ability of *Thais haemostoma* to Regenerate Its Drilling Mechanism

The odontophoral process of the prosobranch gastropods is situated at the distal end of the proboscis, which is essentially a very extensible and maneuverable tube extending from the esophageal region, with the mouth at the end. The odontophore consists of a cartilaginous carriage, which licks back and forth while the radular band moves back and forth over it like a belt over a pulley (1, 2). Possibly the radula can also be held stationary at times, with the sole movement being made by the cartilaginous carriage. This may account for the differences in observations made by some famous zoologists in the past century (1). With its

attendant muscles and nerves, the odontophore is a very complicated mechanism (2) and efficiently operates in drilling as if it were a small rotary drum covered with spikes (1).

Hundreds and possibly thousands of species of predatory gastropods drill holes through the shells of other mollusks and extract the meat. It is generally stated that this ability is possessed only by the Naticidae and Muricidae. It should be noted, however, that the Thaisidae have been separated from the Muricidae. In addition, Moore (3) has shown that three species of the Cassidae bore through the calcareous tests of sea urchins and sand dollars.

The odontophore is certainly mechanically efficient, but whether it functions in this manner alone (4) or is sometimes assisted by acids or enzymes is not yet settled (5). Furthermore, *Thais haemostoma*, the Gulf oyster borer, which is at times a very serious oyster pest, can open oysters without leaving any sign of shell damage whatsoever. This raises the question of whether the animal makes use of some paralytic agent.

In an attempt to answer this question, we cut off the proboscis of several *Thais* with a razor blade. This was done after the hungry animals had been induced to extend the proboscis through a small hole in a plate of plastic to reach a piece of oyster meat placed to one side. The cutting movement had to be swift, for the proboscis is very sensitive and can be retracted with the speed of a rubber band. It was noted that "conchs" that had the proboscis cut cleanly survived, while those suffering jagged cuts did not. Only the distal portion of the proboscis containing the odontophore was cut off. These were preserved in formalin. The supposition was that these "aradulate" gastropods might open oysters by use of a paralytic agent, if they possessed one.

The planned experiment was a complete failure, but the results were nonetheless startling. Within 3 weeks, the surviving gastropods all regenerated the complete odontophoral process, as good as new, and without abnormalities as far as we can determine. The odontophore, consisting as it does of muscle, nerves, cartilage, and chitinous teeth in a band, which undergo a complex but coordinated set of movements, may well be the most complicated organ any animal is able to regenerate. The complexity of the odontophore has been shown best by the detailed anatomical studies of Carricker (2) on *Urosalpinx*. The anatomy of *Thais* has not been described, but it is very similar.

The morphogenetic processes involved in the regeneration of this complicated organ may or may not yield easily to analysis. The apparatus lies in a tube,

but it probably will not be extruded by the animals while healing. In any case, some interesting questions are raised and other workers may wish to take advantage of this type of material.

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30 January 1956

New Evidence for Reversal of the Geomagnetic Field Near the Pliocene-Pleistocene Boundary

It has been shown (1) that, almost without exception, undisturbed Cenozoic lava flows are magnetized roughly in the direction of the present geomagnetic field or at 180° to this direction, termed normal (N) and reversed (R), respectively. There are two conflicting interpretations of how this thermoremanent magnetization was acquired.

1) The geomagnetic field has two stable configurations, those of an axial geocentric dipole of either polarity. Change from one polarity to the other happens in a time of the order of some thousands of years and occurs a number of times in the Cenozoic period, the last occasion being about the Pliocene-Pleistocene boundary. The total time during which the field was reversed in Cenozoic times appears to be roughly the same as that during which the field was normal.

2) In about 50 percent of the lava flows, the iron oxide minerals responsible for the magnetization possess the anomalous property of spontaneously reversing the magnetization acquired during the first stages of cooling below the Curie point. This occurs either during the final stages of cooling or slowly through the time between the eruption and the present day. In the former case, certain interactions between two lattice sites or two phases must be assumed; in the latter case, diffusion of ions between lattice sites or chemical changes or exsolution must be postulated.

No simple decisive test of these hypotheses has so far been proposed. Geologic time correlation is not sufficiently good to allow the magnetization of lava flows of the same age in different places to be compared, nor can any laboratory tests entirely exclude the possibility that the anomalous properties required for the second hypothesis were not pres-

ent during the time when the present magnetization was acquired. Apparently, the best procedure is to continue to accumulate field evidence.

It was possible (2) last summer to make a survey of the remanent magnetization of some of the lava flows of the San Francisco Mountain, Verde Valley, and Mormon Mountain volcanic fields in northern Arizona. It was thought sufficient to determine the polarity rather than the exact direction of magnetization of the specimens. For this it is possible in the majority of cases to use a Brunton compass. Assuming that the specimen is magnetized normally or reversely, the poles of the specimen are brought near the poles of the compass, and repulsion or attraction is noted. Increased sensitivity can be obtained by moving a pole of the specimen from side to side over one end of the compass needle and noting whether the needle moves in phase or antiphase with the specimen.

Occasionally, a few specimens in a single flow were found to be magnetized differently from the rest, but, as these specimens were usually very intensely magnetized and had been collected from exposed points, it was assumed that lightning strokes were responsible.

From the extent of the erosion of the lava tops and fronts, Colton (3) has arranged the lavas of the San Francisco volcanic field in order of age, stage I being the oldest, stage V the youngest. Sharp (4) considers stage III lavas to be younger than about 60,000 years and stage II lavas probably older. Robinson (5) considers the earliest flows in this region to be Pliocene. Work done by Childs (6) on pediplane surfaces of the Colorado plateau shows that the stage I flows rest on a late Pliocene surface and that the stage II flows occurred before the first glaciation in the San Francisco peaks, probably in the early Pleistocene.

Nine stage III flows, one stage IV, and one stage V flow were examined and found to be normally magnetized. This is in accord with the evidence from the New England varved clays which cover a fair proportion of this time. The data from Iceland and France would indicate that stage II covers the Pliocene-Pleistocene boundary. One out of six lavas examined in the Verde Valley volcanic field was reversely magnetized, and 13 out of 21 in the Mormon Lake volcanic field were reversely magnetized.

All these flows were of stage I or II. In these fields, one normally magnetized lava and two reversely magnetized flows have been found overlying baked clay horizons. The latter were found to be magnetized concordantly with the respective lavas. The clay was thus heated by the lava and, on cooling, acquired a

magnetization in the same direction as the lava. If the second hypothesis were true, this would not always occur.

The results that very recent flows are always found to be normally magnetized and baked clays have the same magnetization as the lava which bakes them are in accord with evidence from other lava series. It must be concluded that this evidence from northern Arizona lends support to the first hypothesis. If this hypothesis is correct, the earlier flows in this region must be at least about 1 million years old (7).

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1 February 1956

Ecosystem as the Basic Unit in Ecology

The term *ecosystem* was proposed by Tansley (1) as a name for the interaction system comprising living things together with their nonliving habitat. Tansley regarded the ecosystem as including "not only the organism-complex, but also the whole complex of physical factors forming what we call the environment." He thus applied the term specifically to that level of biological organization represented by such units as the community and the biome. I here suggest that it is logically appropriate and desirable to extend the application of the concept and the term to include organization levels other than that of the community.

In its fundamental aspects, an ecosystem involves the circulation, transformation, and accumulation of energy and matter through the medium of living things and their activities. Photosynthesis, decomposition, herbivory, predation, parasitism, and other symbiotic activities are among the principal biological processes responsible for the transport and storage of materials and energy, and the interactions of the organisms engaged in these activities provide the pathways of distribution. The food-chain is an exam-

ple of such a pathway. In the nonliving part of the ecosystem, circulation of energy and matter is completed by such physical processes as evaporation and precipitation, erosion and deposition. The ecologist, then, is primarily concerned with the quantities of matter and energy that pass through a given ecosystem and with the rates at which they do so. Of almost equal importance, however, are the kinds of organisms that are present in any particular ecosystem and the roles that they occupy in its structure and organization. Thus, both quantitative and qualitative aspects need to be considered in the description and comparison of ecosystems.

Ecosystems are further characterized by a multiplicity of regulatory mechanisms, which, in limiting the numbers of organisms present and in influencing their physiology and behavior, control the quantities and rates of movement of both matter and energy. Processes of growth and reproduction, agencies of mortality (physical as well as biological), patterns of immigration and emigration, and habits of adaptive significance are among the more important groups of regulatory mechanisms. In the absence of such mechanisms, no ecosystem could continue to persist and maintain its identity.

The assemblage of plants and animals visualized by Tansley as an integral part of the ecosystem usually consists of numerous species, each represented by a population of individual organisms. However, each population can be regarded as an entity in its own right, interacting with its environment (which may include other organisms as well as physical features of the habitat) to form a system of lower rank that likewise involves the distribution of matter and energy. In turn, each individual animal or plant, together with its particular microenvironment, constitutes a system of still lower rank. Or we may wish to take a world view of life and look upon the biosphere with its total environment as a gigantic ecosystem. Regardless of the level on which life is examined, the ecosystem concept can appropriately be applied. The ecosystem thus stands as a basic unit of ecology, a unit that is as important to this field of natural science as the species is to taxonomy and systematics. In any given case, the particular level on which the ecosystem is being studied can be specified with a qualifying adjective—for example, community ecosystem, population ecosystem, and so forth.

All ranks of ecosystems are open systems, not closed ones. Energy and matter continually escape from them in the course of the processes of life, and they must be replaced if the system is to continue to function. The pathways of loss and replacement of matter and energy

frequently connect one ecosystem with another, and therefore it is often difficult to determine the limits of a given ecosystem. This has led some ecologists to reject the ecosystem concept as unrealistic and of little use in description or analysis. One is reminded, however, of the fact that it is also difficult, if not impossible, to delimit a species from its ancestral or derivative species or from both; yet this does not destroy the value of the concept. The ecosystem concept may indeed be more useful when it is employed in relation to the community than to the population or individual, for its limits may be more easily determined on that level. Nevertheless, its application to all levels seems fully justified.

The concept of the ecosystem has been described under many names, among them those of *microcosm* (2), *naturkomplex* (3), *holocene* (4) and *biosystem* (5). Tansley's term seems most successfully to convey its meaning and has in fact been accepted by a large number of present-day ecologists. I hope that it will eventually be adopted universally and that its application will be expanded beyond its original use to include other levels of biological organization. Recognition of the ecosystem as the basic unit in ecology would be helpful in focussing attention upon the truly fundamental aspects of this rapidly developing science.

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30 January 1956

Hypothermia by Internal Cooling

Mammals normally maintain their body temperatures at a constant and relatively high level. Chemical and other body reactions speed up with increase in temperature and slow down at lower temperatures. Chemical-reaction rates approximately double for each 20-deg rise in temperature.

In surgery it is desirable to slow down body reactions to allow more time for certain operations (1, 2). Hypothermia has been used with some success in such work, but the cooling methods that were used introduced several problems, such as ventricular fibrillation, the necessity of prolonged preoperative preparation of the patient, and, most important of all, the biological catastrophe of overreaction

Table 1. Temperatures for 11 dogs during hypothermia experiments.

DOG NO.	INITIAL RECTAL TEMP.	MAXIMUM HYPOTHERMAL RECTAL TEMP.	TEMP. CAROTID ARTERY LIMB		TEMP. FEMORAL VEIN LIMB		TEMP. AFTER REWARMING	CONDITION OF DOG
			INITIAL	REWARM	INITIAL	REWARM		
1	100°	80°	78°	72°	72°	79°	96°	FULL
2	102°	80°	86°	80°	71°	86°	94°	RECOVERY
3	104°	85°	37.6°	81°	76°	82°	92°	11
4	100°	82°	87°	84°	67°	84°	94°	11
5	102°	86°	92°	80°	72°	86°	80°	11
6	103°	76°	82°	75°	73°	85°	90°	11
7	100°	78°	85°	76°	76°	81°	88°	11
8	100°	79°	81°	76°	66°	77°	96°	11
9	104°	76°	84°	78°	68°	80°	92°	11
10	100°	80°	78°	82°	66°	78°	88°	11
11	102°	80°	76°	74°	66°	78°	90°	11

tion of the organism to the stress of the shock of surface cold application (3). Cooling the body from the outside requires a long time to extract the body heat through the outer layers of fat and muscular natural insulation (1, 4). It seemed to us that a more rapid lowering of the body temperature could be accomplished by internal cooling through the lowering of the temperature of the animal's circulating blood in an external heat exchanger. The cooled blood returning to the body would act as a heat-absorbing and transferring medium to reduce rapidly the body temperature.

To accomplish this, the following procedure is used. After minimal anesthesia with intravenous Nembutal and with tracheal intubation, the animal is connected to a respirator. The carotid artery is cannulated with a polyethylene tube that is threaded through a circulating pump and is then coiled around a spindle that is immersed in a refrigerated alcohol-water bath. The return end of the polyethylene tube is then inserted in the femoral vein.

In a series of 30 dogs, very good results have been obtained. A dog is cooled from 100°F to 80°F in 20 minutes. No cardiac fibrillation, shivering, or shock manifestations are encountered during the procedure. Several animals have been cooled to a complete cardiac standstill and then returned to normal rate and rhythm by rewarming (Fig. 1). It is necessary only to bring the dog up to 90°F, which is above the shivering point. The animal recovers to normal by itself after this.

Rewarming is accomplished by the use of a heating unit in the cooling bath. The refrigeration is shut off, and the heating unit is activated to warm gradually the bath, which in turn warms the circulating blood of the animal (Table 1).

By this method of producing hypothermia by internal heat exchange, the blood and body temperatures may be

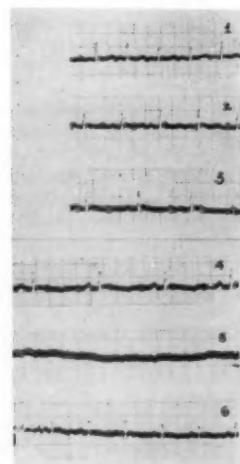


Fig. 1. Cardiographs of dog: (1) normal sinus rhythm, prehypothermia; (2, 3, 4) increasing R-R internal and prophasic delay in repolarization of myocardium, shown by markedly prolonged electric systole; (5) apparent cardiac asystole; (6) sinus rhythm, early posthypothermia.

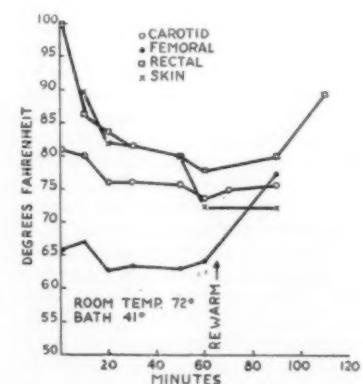


Fig. 2. Related temperatures during hypothermia.

easily and quickly lowered or raised (Fig. 2). Thus, the necessity of a time-consuming prehypothermic state, the shock of surface cooling with the subsequent biological catastrophe of the "stress phenomenon," and the arrhythmia of ventricular fibrillation that are encountered in previously used external cooling methods are eliminated by use of this internal method.

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19 December 1955

Anaphylactic Shock in Guinea Pigs Sensitized to Polytyrosylgelatin

The lack of antigenicity of gelatin has been explained by the deficiency of aromatic groups in this protein. As a matter of fact, the attachment of O- β -glucosido-N-carbobenzoxytyrosine (1) or N-carbobenzoxytyrosine (2) to gelatin gave substances which elicited the production of antibodies. The finding of Maurer (3) that gelatin shows weak antigenic character in man does not seem to invalidate the assumed role of tyrosine in enhancing antigenicity. In this paper, we want to report the sensitization of guinea pigs by repeated injections of a modified gelatin in which L-tyrosine polypeptides are attached to the free amino groups of gelatin through peptide bonds (4).

The polytyrosylgelatin was prepared as follows: O-carbobenzoxy-N-carboxy-L-tyrosine anhydride (5) was polymerized in aqueous dioxane solution (1 to 1) at pH 7.0 (phosphate buffer) and 5°C in the presence of gelatin (6), containing less than 1 percent tyrosine. The carbobenzoxy groups of the polycarbobenzoxy-L-tyrosylgelatin obtained were removed with anhydrous hydrogen bromide in glacial acetic acid, and the product formed was dialyzed against water. The polytyrosylgelatin that was obtained contained 16 percent tyro-

sine as determined spectrophotometrically. Unlike poly-L-tyrosine, which is soluble in water only in the presence of strong alkali (5), polytyrosylgelatin is soluble in water, acids, and bases. Since polytyrosine is insoluble at physiological pH, a copolymer of L-aspartic acid and L-tyrosine in a residue molar ratio of 9 to 1 was prepared for comparison.

Guinea pigs weighing 200 to 250 g received intra-abdominally three injections of 0.5, 1.0, and 2.0 ml, respectively, of the substance to be tested for its sensitizing potency. Five-percent solutions of gelatin and polytyrosylgelatin and 1-percent solutions of the copolymer of tyrosine and aspartic acid were used, and the injections were given at 3-day intervals. Fifteen days after the last intra-abdominal injection, all the pretreated animals, as well as an equal number of nontreated controls, received intracardial injections of 0.25 ml of solutions of the substances to be tested for their antigenicity.

Two out of five guinea pigs that were sensitized with polytyrosylgelatin exhibited large drops in body temperature after an intracardial injection of a 0.2-percent solution of the homologous substance, while three showed typical anaphylactic shocks and died (see Table 1). No serious symptoms were observed in nonsensitized animals or in animals that were pretreated with the copolymer, even when 2-percent solutions of polytyrosylgelatin were injected. Gelatin injected as a 5-percent solution, or the copolymer as a 1-percent solution, did not produce in sensitized or in untreated animals any significant symptoms except slight drops in temperature.

The results obtained (Table 1) show clearly that polytyrosylgelatin injected intra-abdominally sensitizes guinea pigs

Table 1. Anaphylactic reactions in nonsensitized and sensitized guinea pigs. G, gelatin; PTG, poly-L-tyrosylgelatin, containing 16 percent tyrosine; CAT, copolymer of L-aspartic acid and L-tyrosine in a residue molar ratio of 9 to 1.

Previous treatment	Intra-cardial injection	Animals (No.)	Death (No.)	Avg. temperature decreases (°C)
Nonsensitized	G	5	0	0.68
	G	6	0	1.35
Nonsensitized	PTG	5	0	0.80
	PTG	5	3	3.60
	CAT	5	0	0.50
Nonsensitized	CAT	5	0	0.80
	PTG	5	0	1.20
	CAT	5	0	0.40

against intracardial injection of the same compound. Since no sensitization was observed by a similar treatment with gelatin, or with a copolymer of tyrosine and aspartic acid, it seems plausible to assume that the attachment of tyrosine peptides enhances the antigenicity of gelatin.

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6 January 1956

Histological Changes Induced in Soybean Roots by 2,4-Dichlorophenoxyacetic Acid

The anomalous structure caused in the hypocotyl of soybean seedlings by treatment with 2,4-dichlorophenoxyacetic acid (2,4-D) has been reported in an earlier paper (1). The present investigation (2) is concerned with the histological changes in response to treatment with 2,4-D in the primary roots of soybean seedlings. The method used was essentially the same as that described in the earlier paper (1).

Retardation of elongation in the root became apparent on the third day after treatment. The tips of the treated roots were slightly larger in diameter than those of the untreated ones. Histological preparations were made of normal roots and of roots treated with 2,4-D.

Before describing the treatment with 2,4-D, it may be well to review briefly the anatomical structure of the soybean root. The root has a unistratose epidermis. The cortex consists of eight to 11 layers of parenchyma limited on the inside by the endodermis. Immediately within the endodermis lies the pericycle, which is one or two cell layers in thickness adjacent to the primary phloem, and two or three cell layers in thickness opposite the protoxylem ridges. The primary phloem consists of four strands of tissue alternating in position with the protoxylem ridges of the tetrarch structure (Fig. 1).

In the 2,4-D-treated roots, the epider-

mis exhibited no specific response. By the end of 72 hours, however, the cells of the pericycle, endodermis, and inner cortex, in many cases, showed divisions in the radial as well as in the tangential plane (Fig. 2, top). Pericycle cells were especially active, producing a narrow zone of meristematic tissue, which ex-

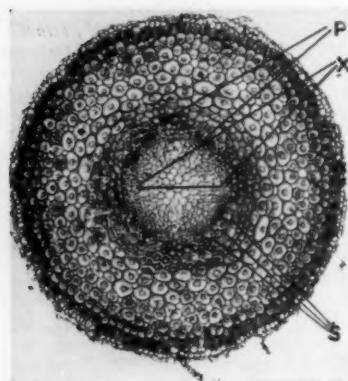


Fig. 1. Transverse section of soybean primary root taken 996 μ behind the stellar initials. *P*, pericycle; *S*, sieve tube; *X*, primary xylem ($\times 79$).

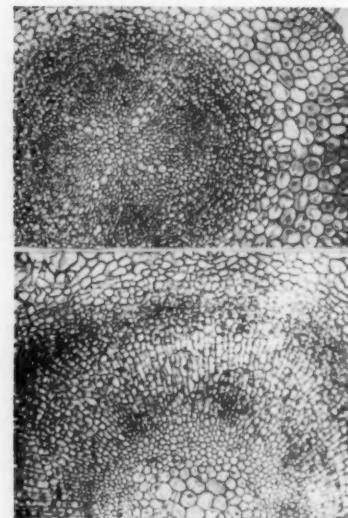


Fig. 2. Transverse sections of soybean primary root, 3 days after treatment with 2,4-D. (Top) Transverse section taken 924 μ behind the stellar initials, showing proliferation of inner cortex, endodermis, and pericycle. (Bottom) Transverse section at the basal region of the primary root showing a conspicuous mass of proliferated tissue produced by the pericycle. The boundaries of pericycle, endodermis, and cortical parenchyma have become indistinguishable. The indented outline suggests the formation of numerous fasciated lateral roots ($\times 68$).

tended well back from the apical region. Active cell division within the pericycle continued until, eventually, the boundary between this tissue and the adjacent tissues became indistinguishable. Because of this active cell division, the pericycle produced a conspicuous mass of dense meristematic tissue, which extended outward toward the periphery (Fig. 2, bottom). The cells of the outer cortex at the basal portion of the root began to collapse during the third day.

The primary phloem also exhibited a similar response to this treatment. At a distance of about 380 μ from the tip, the nonconducting cells of the primary phloem became meristematic. At a greater distance (about 1640 μ from the tip), even greater meristematic activity was apparent. Here the primary phloem, with the exception of the sieve-tube elements, became indistinguishable from the adjoining areas.

Close to the apex there was no response in the primary xylem. Some dividing cells, however, were observed in the metaxylem in the basal regions.

The striking effect of 2,4-D on the root of soybean is a stimulation of cells in certain tissues to high meristematic activity. The resulting mass of cells is non-polarized and does not seem to be made up of numerous, closely placed lateral-root primordia as has been suggested by Wilde (3). Apparently 2,4-D retards root elongation and disrupts the orderly biochemical and physiological processes of normal development, particularly within the stele and inner cortex, resulting in a change to high meristematic activity within these regions.

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18 January 1956

Disease in the Giant African Snail *Achatina fulica* Bowdich

Between March and December 1954, an investigation was conducted to determine the causes for the recent sharp decline in Ceylon populations of the giant African snail (*Achatina fulica* Bowdich) (1). One of the most striking aspects of the field research was that in some areas, even after hours of collecting and examining individuals, the oldest live specimens were found to be no more than 1.5 years old.

In many populations, the oldest live specimens were between 2 and 3 years of

age, although dead specimens in excess of 5 to 6 years of age were almost countless. In other areas, long hours of diligent hunting failed to bring to light a single live specimen in spite of the fact that 2 to 3 years earlier the place had been overrun with snails.

The last sudden decline in the snail populations in Ceylon took place in 1952, a year during which the large stores of metaldehyde that had been purchased as a result of numerous outbreaks of snails in 1951 were scarcely touched. This reflects a cataclysmic decimation, and perhaps even a near or actual local extermination, of the population. The uniformity of age and the conspicuous absence of older individuals suggest that the present populations are the surviving offspring of those subjected to this catastrophic force. As had earlier been anticipated (2), the picture in general was found to be not that of predation but of parasitism or pathogenesis with variable, localized predation.

Of the several predators, only the firefly *Lamprophorus tenebrosus* appeared to offer any possibility as an agent in the biological control of the giant snail. In one area near Pallekelle in the Central Province, however, the fireflies and achatinas had been together for a minimum of 25 years, and the snails could still be classed as "common to abundant" in spite of reasonably common fireflies. Further, it was established both in the laboratory and in the field that the larger the giant snail, the less likely it was to be attacked and killed by the glowworm larva. Therefore, predation by glowworms cannot explain the complete absence of older individuals in some of the erstwhile large, vigorous populations.

In seeking a cause for the manifest sharp decline in the populations of the giant African snail in Ceylon, I found that the greatest amount of evidence pointed toward the existence of a non-specific, chronic disease of uncertain etiology. In the many different environments examined, the only discernible common factor that was unfavorable to the survival of the snails was a fairly constant syndrome. The most conspicuous symptom of this syndrome was the presence of leukodermic lesions on the fore part of the body (Fig. 1).

The first sign of pathogenesis is the presence of vague, patchy, granular areas on the tentacles, face, and neck. Microscopic examination reveals that the melanophores in the dermis of these areas are undergoing complete disintegration and disappearance. Concomitantly, there is a proliferation of dermal connective tissue cells. The epidermis, however, remains intact. Hence, there is no appearance of frank ulceration. But the epidermis reflects the dermal disturbances by



Fig. 1. *Achatina fulica*. The right tentacle has become distorted and shortened as a result of pathologic tissue alterations in the dermis. Small, initial, melanotic tubercles appear basally on the left tentacle and on the face.

elevating into verrucous ridges, "horns," and tuberculations, eventually allowing a serious distortion of the tentacle. As the leukodermic lesions enlarge and coalesce, the shortening tentacle remains partially invaginated and ultimately completely invaginated. In some cases, the primary lesion is initially melanotic, but it becomes melanoleukodermic or leukodermic as melanolysis continues. Evidence shows that there is some slow regeneration of damaged tissue; but the infection spreads to other areas of the body.

Histopathologic examination of the hepatopancreas ("liver") and kidney disclosed marked tissue changes that are the result of either toxemia or the direct action of the pathogen. Other organs doubtless will be found also to be involved in the visceral phase of the disease. Any pathology in the reproductive tract naturally would be significant both in its possible effect upon fecundity (and therefore the size of the population) and in a possible transovarian mode of transmission.

The incidence of the disease in the populations of the giant snail in Ceylon is high, varying approximately from 35 percent to 60 percent. Experiments suggest that the incubation period is reasonably short; that the disease is highly contagious; that, at least initially, there is relatively little natural immunity to the disease; and that contact is one of the modes of transmission. This latter point has implicated the ubiquitous phorid flies (*Spinophora* sp.) as possible mechanical or even cyclical vectors and has implied a direct correlation between population density and incidence of the disease.

The epizootiologic picture is that of a chronic, endemic disease with low gastropod host specificity. Typical symptoms

were found in all endemic snails examined in any quantity. Since the disease was found in populations of native snails far from the frontier of invasion of the giant snail, the inference is that the disease was in Ceylon before the arrival of *A. fulica*. But until the nature of transmission is completely understood, an antibiotic hypothesis cannot be ruled out as a possibility.

Without exception, every population of the giant snail in Ceylon which was examined not only had diseased individuals, but had many of them. The high incidence of the disease apparently has assured infectivity in specimens introduced into uninfested areas. It therefore was not surprising to find the disease present in achatinas in Singapore (66 percent of 33 specimens) and Hong Kong (40 percent of 63 specimens), nor is it difficult to predict that it will be found in Indonesia, Formosa, and the Trust Territory of the Pacific Islands. It is significant that a decline in the population has been reported from all of these areas.

The incidence of the disease in the Hawaiian specimens is appreciably lower (10 to 23 percent), and this quite possibly reflects the fact that the population is still in the early stage of invasion. The slow development of the population undoubtedly is due entirely to the limiting effects of rigorous control measures that have been carried out by the Hawaiian government since 1938. But the recent extension of the range of *A. fulica* in Hawaii indicates that there is a transition in progress which may result in a full blossoming of the snail pest within the next few years, despite efforts to prevent it. Any prognostication might well be based on the history of the giant snail population in Hong Kong. This population grew to prodigious size despite control measures and the presence of the disease, but it is now in a definite decline, and there are only occasional reports of localized buildup and damage.

Because of the lack of control specimens in Ceylon, the causative agent of the disease could not be identified with certainty. However, culture plates and tissue smears and slides indicated that it is unlikely that the disease is caused by a spirochete, protozoan, yeast, or fungus. This leaves essentially the bacteria and viruses. A coccus form was frequently isolated, but it may have been a contaminant. Inoculation experiments are currently being planned to determine positively the etiologic agent. Both field and laboratory work have eliminated the possibility that the symptoms are simply physical or physiologic reactions to unfavorable environmental factors (3).

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1. This investigation was sponsored by the National Science Foundation (NSF-G519). Grateful acknowledgment is made for the kind assistance of the following members of the Department of Agriculture, Peradeniya, Ceylon: H. Fernando and V. Elikawela of the division of entomology; Dr. Peiris of the division of plant pathology; and A. Bandaranayake and W. Fernando of the Veterinary Research Laboratory. The photograph was taken by R. van Cuylenburg of Colombo, Ceylon.
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13 December 1955

Ivory-Nut Palm from Late Tertiary of Ecuador

During his geologic explorations in South America, A. A. Olsson, of Coral Gables, Fla., has, on several occasions, had the good fortune to find interesting and significant fossil plants. In 1945, for example, he collected well-preserved, carbonized walnuts from marine outcrops near Esmeraldas, Ecuador, which I described as *Juglans linkii* (1). In 1955, about 10 mi east of the walnut locality but at about the same stratigraphic level, he found a fossil tagua or ivory-nut, (*Phytelephas olsoni* Brown, n. sp.).

This fossil nut (Fig. 1) is similar to those produced by species of the palm genus *Phytelephas*, rounded-angular, 4.5 cm long, 4 cm in diameter, showing two flattened faces whose narrowed ends converge toward an apical depression, the raphe. The surface is lined by more or less irregular, shallow, veinlike, interconnecting furrows.

The fossil is a sandstone cast, most probably the filling of the thin and brittle endocarp covering the nut. It was taken from the Punta Gorda formation of late Miocene or early Pliocene age that crops out at Quebrada Camarones. Apparently the fleshy part of the original nut either decayed or was eaten out by marine organisms, permitting sand to fill the resulting cavity. The granules of the

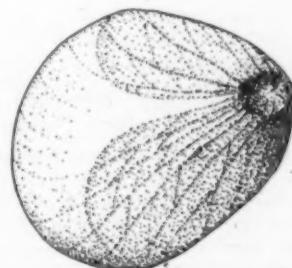


Fig. 1. Sandstone cast of a late Tertiary ivory-nut, *Phytelephas olsoni* Brown, n. sp. (natural size.)

cast include quartz, glauconite, and numerous foraminifers, with a clay binder. The living nut very likely came from a plant that grew on or near the coast and was washed into fairly deep water, as the kinds of globigerinid foraminifers seem to indicate.

The nuts of *Phytelephas* palms are at first relatively soft and edible but on ripening become very hard, with an ivorystyle endosperm, and are enclosed in a thin skin or endocarp. Four or more of these covered nuts, closely pressed together (hence the angular faces) make a burlike or warty cluster. They supply much of the "vegetable ivory" of commerce from which buttons and other articles are turned.

The species of *Phytelephas*, variously estimated from 3 to 15 in number, include low, erect or prostrate plants with graceful, arching, pinnate leaves that are sometimes 15 to 20 ft long. The commonest species is *P. macrocarpa* Ruiz and Pavon, which is widely esteemed and cultivated. The genus inhabits tropical America, and the species grow along streams and swamps, generally in coastal situations.

The fossil record of the palms dates back certainly to the early Jurassic, as exemplified by impressions of fan-shaped leaves from Normandy, and perhaps to the Triassic, if the palmlike leaves I have described (2) from southwestern Colorado are indeed palms and not some other monocotyledon. The only other record of fossil *Phytelephas*, however, is part of a stem from the Miocene of Antigua, described as *P. sewardi* Kaul (3), and now in the Natural History Museum, South Kensington, London.

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6 February 1956

Effect of Gibberellin on Elongation, Water Uptake, and Respiration of Pea-Stem Sections

Gibberellin, which induces hyperelongation in many kinds of green plants (1), has been shown (2) to be a type of substance that has growth effects different from those of auxin. It reduces the growth inhibition brought about by con-

Table 1. Effect of gibberellin (10 mg/lit) and pH on the elongation of pea-stem sections in 24 hours. Initial length, 5 mm. Each value is the average of ten sections.

pH	Increase in length of section (mm)		Increase over control (%)
	Control	Gibberellin	
5.3	1.11	1.71	54
6.0	1.02	1.63	60
7.0	0.74	1.30	76
8.0	0.66	0.97	47

centrated solutions of auxin and by some other growth inhibitors, such as maleic hydrazide (3). It exerts no effect on root growth but inhibits root formation (3).

Preliminary to a study of the mechanism of action of gibberellin, its effects on elongation, on water uptake, and on respiration of pea-stem sections were examined (4).

Stem sections 5 mm in length were prepared from the third internodes, which were about 15 to 20 mm in length, of etiolated pea seedlings that had been grown for 7 days in a darkroom at 25°C. The sections were set afloat in 0.03M phosphate buffer solutions at pH 7.0, with and without addition of crystalline gibberellin A (5), and were kept in the same darkroom until the experiments were finished.

As is shown in Table 1, pea-stem sections elongated in acid solution, either with or without gibberellin. If the elongation of gibberellin-treated sections is compared with that of the controls at the same pH, it may be seen that the effect of gibberellin is most pronounced at pH 7.0.

Water uptake was determined by the increase in 24 hours in fresh weight of stem sections. Just as in the case of elongation, water uptake was higher in acid solution, and the effect of gibberellin was the greatest at pH 7.0 (Table 2).

The oxygen uptake of freshly prepared pea-stem sections was measured, using the Warburg respirometer, which was shaken at 80 rev/min at 30°C in the dark. Each flask contained ten sections, bathed in 2 ml of 0.03M phosphate buffer solution, with or without 10 mg/lit of gibberellin. Experiments ran for 4.5 hr; they were preceded by a 1/2-hour equilibration period. The results, presented in Table 3, show that the oxygen uptake of stem sections stimulated by gibberellin was about 15 percent greater than that of the controls. When the sections were pretreated by 10 mg/lit of gibberellin

Table 2. Effect of gibberellin (10 mg/lit) and pH on the water uptake of pea-stem sections. Each value is the average of values obtained in three experiments.

pH	Water uptake (% of initial fresh wt.)		Increase over control (%)
	Control	Gibberellin	
5.3	42	57	36
6.0	49	69	41
7.0	25	40	60
8.3	31	36	16

Table 3. Effect of gibberellin (10 mg/lit) on the respiration of pea-stem sections.

Expt. No.	O ₂ uptake [μ lit/10 mg (dry wt) hr]		Increase over control (%)
	Control	Gibberellin	
1	52.0	59.6	15
2	51.3	59.2	16
3	45.3	52.2	15
Average			15

for 8 hours, their oxygen uptake was about 20 percent higher than that of controls, other conditions being the same.

The effect of gibberellin in stimulating respiration was not observed with stem sections from the first and second internodes.

Although gibberellin does not cause the inward curvature of split pea stem as do auxins (2), it does increase the elongation and the water absorption of the unsplit material. The essential difference in the physiological effects of gibberellin and auxin is not yet known. Some clue to this difference may be found when the effects of enzyme inhibitors on the gibberellin-stimulated respiration are studied and compared with the effects described for auxin-induced respiration.

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8 February 1956

They know enough who know how to learn.—HENRY ADAMS.

Book Reviews

The Torment of Secrecy. The background and consequences of American security policies. Edward A. Shils. Free Press, Glencoe, Ill., 1956. 238 pp. \$3.50.

The Torment of Secrecy is a sensitive and penetrating analysis of a nation suffering from what can be described only as multiple schizophrenia. For in the United States the familiar ambivalence, found everywhere, between freedom and conformity is compounded and confounded by tensions arising from a passion for publicity at the expense of privacy and at the same time a childlike faith in Secrecy as a bulwark of Security. De Tocqueville long ago commented on the unique and all-powerful role of public opinion in American culture and expressed misgivings lest it result in the triumph of conformity and the sacrifice of freedom and diversity.

This passionate faith in public opinion, or, as Edward Shils would have it, in publicity, is not directed against privacy as such but at privacy as a sign of dissent—for dissent may breed disloyalty. Within this unexposed area of privacy the "mass" man may well ask, "What dire deeds are being planned? What dire why insist on privacy? If one has nothing to conceal, why fear publicity?"

Fear of privacy is bound to be exaggerated in a closed and stratified society in which the ruling élite is forever fearful of revolt from those who may challenge its legitimacy. Czarist Russia, for example, was thus obsessed with a conspiratorial view of social and political intercourse. Continuous surveillance by secret police and an army of informers was matched by systematic efforts to enforce conformity through control of education, religion and communication and through periodic campaigns of what the Czar called Russification. All such tendencies are intensified where a monolithic or rigidly hierarchical view of society prevails—where State and Society are for practical purposes indistinguishable. A pluralistic society, on the other hand, can afford both publicity and privacy, since Society (in the sense of family, church, trade unions, and other associations) is at the same time greater

than, and independent of, the State. The right to privacy, in democratic societies at least, does not normally extend to affairs of state.

In nondemocratic societies privacy as an attribute of the ruling élite becomes Secrecy, which raises "higher and more impassable barriers" to publicity. For, as Shils says, "Secrecy is Privacy made compulsory." I think it was James I who said that "one must not inquire into the mystery that surrounds a king," and some such notion applies more or less to all nondemocratic states. But democracy is as much opposed to secrecy in government as it is dedicated to the right of privacy for its citizens. Bills of Rights and other devices to guarantee and protect diversity of association and expression reflect the latter as the expression "public affairs," as a synonym for affairs of state, reflects the former. Democratic governments live in goldfish bowls, subject at all times to "pitiless publicity." Secrecy is suspect, and "state secrets" must justify themselves, if at all, not as an expression of the right to privacy for a ruling élite or even as a necessary attribute of the process of government, but as indispensable to national security and the whole democratic way of life.

In no country is state secrecy more suspect than in America. But in recent years we have been so obsessed with Secrecy as a bulwark of national security that we have all but extinguished the right of privacy. "In order for secrets to be safeguarded," says Shils, "privacy must be invaded. The security of secrets has come to require not only physical security and classification"; it requires that personnel be free of any taint that might lead to the betrayal of state secrets. "The idea that the breaches in security are dependent on dispositional factors, such as political attitudes or personal propensities, is the foundation of the disruption of privacy by secrecy." The result has been that a democratic, pluralistic, populistic nation has taken on to an alarming degree the ideology and apparatus of a totalitarian, monolithic, nondemocratic society. Secret police, paid anonymous informers, spies, and counterspies, investigators turned inquisitors, have appeared; and guilt by association, if not guilty by mere accusation,

has become a feature of legislative and even quasi-judicial proceedings, on the assumption that nearly everyone is a potential spy or saboteur and that a man is guilty until he proves his innocence.

In an age of science and technology and of sharply conflicting national ideologies it is not surprising that intellectuals, and especially scientists, should be special objects of concern to those who equate secrecy with security.

"There is an inner affinity between science and the pluralistic society," says Shils. "The conduct of scientific research requires a pattern of relationships among scientists which is the prototype of the free society. . . . The community of science is built around the free communication of ideas among a relatively small number of intellectually interested and qualified persons whose judgment is recognized to be a measure of validity, and whose approbation gives confidence in the truthfulness of discoveries and in the fruitfulness of the paths traversed . . .

"The standard of truth in science has nothing to do with the criteria of political success or of political loyalty. . . . The autonomy of science is infringed on when scientists who are qualified by their training, personal qualities and intellectual gifts, as assessed by their peers and seniors, are prevented for extrascientific reasons from working on problems on which research is possible and for which resources are available. It is infringed on when scientists are unable to discuss, publish, or circulate their work to other scientists interested in the same or related problems. It is infringed on when scientists are unable to leave their country or to enter another country to attend a scientific congress because the government in the country from which they come or to which they wish to go is concerned about their ideological adequacy. It is infringed on when talented young scientists are refused grants which are otherwise available and for which they are otherwise qualified, or when older and well-established scientists are refused research grants for which their achievements and reputation qualify them because their ideological disposition is adjudged to be unsatisfactory."

All of these things have happened, not only to scientists, but to intellectuals generally, and have helped to produce that "torment of secrecy" of which Shils writes. For the scientist and the intellectual are by nature and function questing, critical minds, forever asking *how* and *why* and thus subjecting to constant scrutiny the most precious of all tribal loyalties, including those official secrets upon which security is thought to depend.

It remains to ask, How come? How could democratic, pluralistic America get itself in such a fix? Shils, I believe,

is inclined to lay too much to what he calls our "populistic tradition." In my judgment there is at least one other factor of critical importance.

An obsessive fear of both privacy and secrecy may develop in a society whose population is composed of heterogeneous and mutually hostile racial, nationality, ethnic, religious, or political elements. The English can afford to be indulgent of those who differ or dissent, or who insist that their private affairs are no concern of the state or public opinion. As Shils observes, "Mutual trust (in Britain) reduces the fear of secretiveness and the need for publicity." In America, however, the same influences that operate to create attitudes of freedom and toleration toward differences—that is, a heterogeneous population in an extensive land, operate also to produce fear of diversity, especially when these differences take, or appear to take, a political turn. The American knows well that in a nation composed of men and women of nearly every conceivable national, racial, or religious heritage, toleration of religious and cultural differences is a condition of survival. Otherwise we might quickly revert to that state of nature of which Hobbes spoke. But the limits of this toleration, although vague and variable, are nevertheless real, particularly when political values are involved.

Without a common culture, with historical, religious, and literary traditions as diverse as the groups entering into the so-called "melting pot," and to a large extent lacking even a common language, the nascent Americans looked for a common bond of unity in the political and economic institutions of their adopted land.

The very differences that produced a tradition of toleration on the cultural level produced an equally fanatical belief in the necessity for conformity in political and economic ideas. Hence, the passion for Americanization, for loud and repeated affirmation of devotion to the Constitution, the Declaration of Independence, Free Enterprise, and other signs and symbols of a common political and economic loyalty. It is a loyalty, be it noted, not to any omnipotent state of Hegelian or Marxist hue, but rather to a set of political ideas that give meaning to our kind of heterogeneous, pluralistic society. Among these is the notion that publicity is a safeguard if not a cure for most political ills. Hence, state secrets too are anathema.

Yet when state secrets are associated with national security and the defense of other democratic values they join the Constitution, the Declaration of Independence, and other symbols of our common political heritage as part of the "ceremonial of solidarity" so important to a heterogeneous, pluralistic people.

No brief review can summarize this searching and stimulating volume. Nowhere have I seen so impressive an analysis of one of the major problems of our time. Shils is no zealot, either of the right or left. He recognizes that in the context of polarized political power a security problem of considerable dimensions confronts all the free nations. His quarrel is with those methods that not only are ineffective in promoting security but actually impair national security by undermining those features of our pluralistic society upon which our national security most depends. His concern is not with security or even with secrecy as such, but with *The Torment of Secrecy*.

PETER H. ODEGARD

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cells. In his presentation of modern problems, methods, and results, the author is mindful of the fact that in the past faulty methods and techniques have been common sources of error. Both the methods and the assumptions on which their procedures are based are therefore carefully examined.

Detailed discussions are given in three sections on the methods used for the determination of intracellular and tissue pH: namely (i) potentiometric methods (hydrogen, platinum, and antimony electrodes; capillary glass electrode; glass electrode); (ii) indicator method (general considerations; vital dyes; acid-base indicators; natural indicators in living cells); and (iii) methods of calculation (Henderson-Hasselbalch equation; zeta potential; buffering power). The actual data are subsequently given in tables systematically from the Protozoa through the Chordata.

In lieu of a summary the author presents a critical discussion of data for pH obtained by different workers, in nucleus, cytoplasm, and vacuole. He concludes that only a few investigators have in the past entirely excluded possible errors involved in the methods used, although it would certainly be incorrect to assume that all cells have the same pH at all times.

ROBERT BLOCH

Biological Abstracts,
University of Pennsylvania

Advances in Carbohydrate Chemistry.
vol. 10. Melville L. Wolfrom and R. Stuart Tipson, Eds. Academic Press, New York, 1955. xx + 437 pp. Illus. \$10.50.

The technical stature of this series of *Advances* is outstanding, and volume 10 is one of the best. Determination of the true value of these volumes is hardly possible, but it is obviously very great. If the present apparently high editorial standards are maintained, carbohydrate chemists can be assured that developments pertinent to their major scientific interests will be continuously reorganized in the light of current needs.

Contributions from 11 well-qualified scientists (one each from Australia, Canada, and Scotland in addition to four each from England and the United States) treat nine subject headings. Because of the detailed exactitude with which each section is handled, perhaps several reviewers rather than a single one would have been more in keeping with the tenor of the work.

"The stereochemistry of cyclic derivatives of carbohydrates" is discussed (J. A. Mills) from a fresh point of view which ultimately should be helpful in

picturing the necessarily complex polycyclic structures encountered by all carbohydrate chemists. Current practices leave much to be desired, and this survey, prepared in the light of terpene and steroid experience, suggests a reasonable approach.

Chromatographic techniques will long retain a position of singular importance. Thus, it is appropriate that the paper chromatography discussion in volume 9 has been followed by one on column chromatography (W. W. Brinkley) in volume 10. Both discussions are excellent. It is indeed fortunate that these literature studies are being provided during this critical period of rapid extension of the principle.

Many of the nitrogen-containing derivatives of sugars and the reactions leading thereto have been surveyed under the headings "Glycosylamines" (G. P. Ellis and John Honeyman) and "The Amadori rearrangement" (John E. Hodge). Although they have long been recognized as being biologically significant, there is still much to be explained in the chemistry of these compounds. These current compilations will be used for a long time by all who work with these difficult and often baffling reactions.

Traditionally, glycosyl halides in the acetylated form are key compounds for the preparation of glycoside derivatives. Being essential for the preparation of many complex derivatives, a study (L. J. Haynes and F. H. Newth) of this group is welcome. Several pages of tabulations of physical constants of glycosyl halides and their derivatives will make the section additionally useful for laboratories with limited library facilities. The same is true for extensive tables of constants (George G. Maher) reported for the methyl ethers of aldopentoses, rhamnose, fucose, and D-galactose.

Polysaccharides associated with cellulose in most of its native forms are diverse in composition and structure. Results from work on these compounds are somewhat obscured in some cases because of the relatively severe treatments to which the original wood was exposed. However, the significant literature has now been reviewed (W. J. Polglase) and organized in a meaningful manner. The question of retention of native qualities has also plagued heparin research, but a survey (A. B. Foster and A. J. Huggard) of recent work indicates that very substantial progress has been made in the study of this biologically important polysaccharide material.

Volume 10 has every right to take its place alongside the earlier members of this series as a near essential for all carbohydrate chemists.

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22 JUNE 1956

Atom und Psyche. Ein Deutungsversuch.

Egon Freiherr von Eickstedt. Ferdinand Enke, Stuttgart, 1954. 158 pp. Cloth, DM. 14.20; paper, DM. 12.

Die Selbstgestaltung des Lebendigen.

Synoptische Theorie des Lebens als ein Beitrag zu den philosophischen Grundlagen der Naturwissenschaft. Karl Friederichs. Ernst Reinhardt, Muenchen-Basel, 1955. 222 pp. Cloth, Fr. 20.50; paper, Fr. 18.

These two volumes can appropriately be reviewed together, not only because they belong to the line of German *Naturphilosophie*, but also because their intention and viewpoints are similar. Both start with the theory of levels or the hierarchy of reality, as was advanced, in Germany, particularly by Nicolai Hartmann. Both try to fit together these eternal antagonists in the world drama, body and mind, conceiving of physical matter, organism, soul, and spirit as layers in the great cake of reality, and arriving at a psychiatrist interpretation similar to that advocated by Sinnott in this country. For the philosophically minded, they will make interesting reading.

Von Eickstedt, the distinguished anthropologist, travels from the subatomic territory via the hierarchy of biological systems to mental phenomena. The elementary units of physics being at the basis of reality, the question is raised whether the psyche also comes in, and concordances may be found between the atomic world of microphysics and the properties of living and animate nature. In fact, many such parallels show up. Behavior at the microphysical level compares to vital rather than to macrophysical phenomena. The elementary processes in physics are beyond space, time, and substance which are only categories of human experience; likewise, the familiar categories of space, time and substance dissolve in narcosis, under mescaline or after traumatic lesions. Microphysics is governed by statistical laws where the individual particle has a "choice" between different possibilities, just as the human individual follows his "free will" and, nevertheless, a statistical law allows us to predict quite exactly the number of suicides in years to come. Amplification of microevents to macrophenomena seems to play a role in biological happenings, as, according to the target theory, one quantum "hit" suffices to produce a mutation, and so forth.

Friederichs, noted for his contributions in the field of applied entomology, calls his theory "autotelism." While giving credit to the approaches made toward teleology by organismic biology, general system theory, cybernetics and cognate approaches, and acknowledging that, according to my own writings, many apparently vitalistic features of the organisms

can be conceived as consequences of their being open systems and steady states, he finds these conceptions shortcoming in view of the *Sinnhaftigkeit* and *Innen* of the organism. The essential limitation of the concept of wholeness is to skip the unspatial component of the organism that has a decisive influence on vital happenings.

Since the success of some 2000 years of philosophy has been indifferent in putting together the physical and psychical halves of the great Humpty Dumpty, no blame can be laid on the erudite authors for not having provided the final solution. We do not judge whether, according to Friederichs, the psychophysical union can be compared to the spatio-temporal union of physics, whether speaking of physical, biological, psychological, and cultural "levels," does not involve a *μετάβασις εις ὅλον γένος*, in how far Eickstedt's parallel between microphysical and psychological happenings is permissible, and so forth. Perhaps the wisest attitude is indicated by Friederichs who, laudatorily commenting on certain statements of the reviewer, says that the latter "appears in Faraday's position when he was asked what electricity is. His answer: 25 years ago I could have told you, but I cannot today."

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Realms of Water. P. H. Kuenen. Revised version translated by May Hollander. Wiley, New York; Cleaver-Hume, London, 1955. 327 pp. Illus. + plates. \$6.50. (Originally published as *De Kringloop Van Het Water*.)

The demands for more and more water that society is making upon science and technology become more pressing with each new day. The increasing industrialization throughout the world, coupled with the unrelenting rise in populations, requires a continuing assessment of our water resources. In order to appraise significantly the world supplies of this precious commodity, we must be aware not only of its distribution over the crust of the earth but also of its travels. P. H. Kuenen has compiled in this new book much of the necessary background information for these problems.

The book treats the journeys of water from its principal reservoir, the oceans, through the atmosphere, glaciers, terrestrial waters, and ground waters, and finally through the rivers back to the oceans. The physical and chemical interactions between water and its various temporary environments are emphasized. Somewhat neglected, however, are the chemical isotopic compositions of natu-

ral waters which can retain a record of their previous history.

A clear picture of the consequential role of the hydrosphere in such phenomena as climate and erosion is put forth. The geologic behavior of water is related to its extraordinary properties: its existence in nature in the gaseous, liquid, and solid states; and its ability to dissolve most substances on the surface of the earth to at least a limited degree.

The author apparently seeks his principal audience in the lay reader. Although the volume abounds in diagrams and pictures, there is a paucity of tables and equations which would have allowed the author to present his arguments more succinctly. Again, some of the illustrations, taken directly from scientific publications, contain notations that are not explained in the text. There are also many inconsistencies in the use of units; for example, salinities are designated as both parts per thousand and parts per hundred in diagrams on the same page (p. 67). Nonetheless, the author is successful in presenting a vigorous and lively history of the travels of water.

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Scripps Institution of Oceanography

New Books

Machine Literature Searching. James W. Perry, Allen Kent, Madeline M. Berry. Western Reserve University Press and Interscience, New York, 1956. 162 pp. \$4.

Elementary Qualitative Analysis (Laboratory manual). Morris F. Stubbs and W. Norton Jones, Jr. Brown, Dubuque, Iowa, 1956. 110 pp. \$2.

The Steel Skeleton, vol. II, *Plastic Behavior and Design*. J. F. Baker, M. R. Horne, J. Heyman. Cambridge University Press, New York, 1956. 408 pp. \$12.

The Changing Universe. The story of the new astronomy. John Pfeiffer. Random House, New York, 1956. 243 pp. \$4.75.

Work and Authority in Industry. Ideologies of management in the course of industrialization. Reinhard Bendix. Wiley, New York; Chapman & Hall, London, 1956. 466 pp. \$7.50.

Annual Review of Medicine, vol. 7. David A. Ryland, Ed. Annual Reviews, Stanford, Calif., 1956. 611 pp. \$7.

Molecular Flow of Gases. G. N. Patterson. Wiley, New York; Chapman & Hall, London, 1956. 217 pp. \$7.50.

Elements of Genetics. Mendel's laws of heredity with special application to man. Edward C. Colin. McGraw-Hill, New York, 1956. 498 pp. \$5.75.

Integral Functions. Cambridge Tracts in Mathematics and Mathematical Physics, No. 44. M. L. Cartwright. Cambridge University Press, New York, 1956. 135 pp. \$3.50.

The Chemical Constitution of Natural Fats. T. P. Hilditch. Wiley, New York, rev. ed. 3, 1956. 664 pp. \$16.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, but to the publisher or agency sponsoring the publication.)

Committee for the White House Conference on Education, a Report to the President. The Committee, Washington, D.C., 1956 (order from Supt. of Documents, GPO, Washington 25). 126 pp. \$0.40.

The Geography, Birds, and Mammals of the Perry River Region. Spec. Publ. No. 3. Harold C. Hanson, Paul Queneau, Peter Scott. Arctic Institute of America, New York, 1956. 96 pp. \$2 (members, \$1).

The Work of WHO 1955. Annual report of the Director General to the World Health Assembly and to the United Nations. Official Records of WHO 67. World Health Organization, Geneva, 1956. 241 pp. \$2.

Scientific Institutions and Scientists in Latin America. Mexico. vol. 3. United Nations Educational, Scientific and Cultural Organization, Montevideo, Uruguay, 1955. 76 pp.

Australian and New Zealand Association for the Advancement of Science, Report of the Thirty-First Meeting. pt. 1. Australian Journal of Science, vol. 18, No. 3A. Fairway Publications, Sydney, Australia, 1956. 48 pp. 4s. 6d.

Federal Aid in West Virginia. Its impact on state government. W. W. Kaempfer. Bureau for Government Research, West Virginia University, Morgantown, 1956. 72 pp.

Safety through Steep Gradient Aircraft. Supplement to 1955 survey reviewing status and special problems of vertical and short take-off and landing types of aircraft. R. M. Woodham. Daniel & Florence Guggenheim Aviation Safety Center at Cornell University, New York-Los Angeles, 1956. 43 pp. \$0.75.

Bibliography of Mining Theses at U.S. Institutions. Howard L. Hartman. *Long-wall Mining of Oil Shale*. Mark J. Waltch and Donald O. Rausch. Quarterly of the Colorado School of Mines, vol. 51, No. 2. Colorado School of Mines, Golden, 1956. 81 pp. \$1.

The Soils of the Katherine-Darwin Region, Northern Territory. Soil Publ. No. 6. G. A. Stewart. Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia, 1956. 68 pp.

Research in Psychosomatic Medicine. No. 3. Psychiatric Research Reports of the American Psychiatric Association. Edited by members of the Committee on Research, 1954-55. Papers presented at the Southern Regional Conference held under the joint auspices of the American Psychiatric Association and Duke University, School of Medicine, Department of Psychiatry, Durham, N.C., 19-20 Nov. 1954. American Psychiatric Association, Washington, D.C., 1956. 93 pp. \$2.

Department of Scientific and Industrial Research, Report for the Year 1954-55. Cmd. 9690. Her Majesty's Stationery Office, London, 1956. 321 pp. 7s. 6d.

Bulletin of the British Museum (Natural History), Entomology. Index to vol. III, 1953-54. British Museum (Natural History), London, 1953-1954. 7 pp.

Poissons Cichlidae. Exploration hydrobiologique du Lac Tanganyika (1946-1947). Résultats Scientifiques, vol. III, pt. 5B. Max Poll. Institut Royal des Sciences Naturelles de Belgique, Brussels, 1956. 619 pp.

The Mosquitoes of Arabia. pt. I. Bull. of the British Museum (Natural History) Entomology, vol. 4, No. 3. P. F. Mattingly and K. L. Knight. 53 pp. 15s. *Microlepidoptera from Lord Howe Island and Norfolk Island*. Bull. Entomology, vol. 4, No. 4. J. D. Bradley. 22 pp. 6s. *Sphecidae* (Hym.) récoltés en Libye et au Tibesti par M. Kenneth M. Guichard. Bull. Entomology, vol. 4, No. 5. Jacques De Beaumont. 51 pp. 15s. *Birds Collected by Mr. F. Shaw-Mayer in the Central Highlands of New Guinea 1950-1951*. Bull. Zoology, vol. 3, No. 10. R. W. Sims. 52 pp. 15s. *British Mites of the Subfamily Macrocheilinae Trägårdh (Gamasina-Macrocheilidae)*. Bull. of the British Museum (Natural History) Zoology, vol. 4, No. 1. G. Owen Evans and E. Browning. 55 pp. 17s. 6d. *The Structure, Evolution and Nomenclature of the Ostracod Hinge*. Bull. Geology, vol. 3, No. 1. P. C. Sylvester-Bradley. 21 pp. 12s. 6d. The British Museum (Natural History), London, 1956.

Instructions for Collectors. No. 11. *Fossils, Minerals and Rocks*. British Museum (Natural History), London, ed. 6, 1956. 16 pp. 1s.

Building Science Directory. pt. 1, *Associations and Societies of the Building Industry in the United States*. National Academy of Sciences-National Research Council, Washington, 1956. 12 pp. \$2.

British Association for the Advancement of Science, Preliminary Programme for the Annual Meeting. Sheffield, 29 Aug.-5 Sept. 1956. British Association for the Advancement of Science, London W.1, 1956. 25 pp.

Second International Congress of the International Union for the Philosophy of Science, Proceedings. Held in Zurich, Switzerland, August 1954. vol. 1, *Plenary Sessions*, 159 pp.; vol. 2, *Physics, Mathematics*, 152 pp.; vol. 3, *Theory of Knowledge, Linguistics*, 170 pp.; vol. 4, *Philosophy and Science, History of Philosophy*, 134 pp.; *Sociology, Psychology*, 107 pp. Dunod, Paris, 1955. Paper, F. 3000 for 5 volumes.

An Anthropological Reconnaissance in the Near East, 1950. Papers of the Peabody Museum of Archaeology and Ethnology, Harvard University, vol. XLVIII, No. 2. Henry Field. Peabody Museum, Cambridge, Mass., 1956. 119 pp. \$2.50.

Low Oxygen Gas Storage Trials of Apples in Tasmania. Div. of Plant Industry Tech. Paper No. 6. D. Martin and J. Cerny. Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia, 1956. 19 pp.

National Institute of Genetics (Japan), Annual Report. No. 5, 1954. National Institute of Genetics, Misima, Sizuoka-ken, Japan, 1955. 90 pp.

Higgins Flat Pueblo, Western New Mexico. Fieldiana: Anthropology, vol. 45. Paul S. Martin, John B. Rinaldo, Elaine A. Bluhm, Hugh C. Cutler. Chicago Natural History Museum, Chicago, Ill., 1956. 218 pp. \$4.50.

Scientific Meetings

American Bacteriologists

The 56th annual meeting of the Society of American Bacteriologists was held 28 Apr.-3 May 1956 at the Shamrock-Hilton Hotel in Houston, Texas. An attendance of more than 1500 scientists marked this first meeting of the society to be held in the Southwest. The 4-day scientific program included papers presented by more than 735 bacteriologists from the United States, Canada, England, the Netherlands, West Germany, the Philippines, Australia, Mexico, and Puerto Rico.

The scientific program featured an excellent group of ten symposia presented at afternoon and evening sessions. The symposium on "Teaching of microbiology" consisted of aspects of teaching to general, advanced, and special groups, such as nursing, dental, and medical students. The "Petroleum microbiology" symposium included reports on the role of microorganisms in corrosion and plugging of oil reservoirs, oxidation of aliphatic hydrocarbons, release of oil from oil-bearing materials, and the effects of high temperatures and great pressures, such as are found in deep wells, on microbial activity.

The symposium on "Microbial amino acids" discussed the biosynthesis of valine, isoleucine and leucine, and the aromatic ring compounds, the cleavage of heterocyclic rings, and the hydroxymethyl and formimino group transfer in serine-glycine interconversion. In the symposium on "The Enterobacteriaceae," attention was confined to the isolation, identification, and pathogenic potentialities of these organisms. The "Industrial Fermentation" symposium considered methods of culture stabilization and improvement, contamination control and testing, microbiological and engineering aspects of fermentation scale-up, and the biochemical activities of the *Streptomyces*.

In the symposium on "Cellular organization in relation to function," attention was given to the organization of respiratory and phosphorylating enzymes. The enzymatic activity associated with particulate and nonparticulate fractions of *Mycobacterium tuberculosis* and their immunogenicity for mice were reported.

The role of particulates and solubilized factors in oxidative phosphorylation by bacterial extracts and their biochemical and cytological properties were discussed. The reports also included evidence for the presence of mitochondria in bacterial cells and lipid synthesis in cell-free extracts.

Antiseptics and growth factors and assay design and analyses were discussed at the "Analytical microbiology" symposium. In the symposium on "New aspects of water bacteriology," reports were made on new differential media, the use of the Millipore filter, the use of infrared spectrophotometry, a new field test for determining the sanitary quality of drinking water, and the use of chelating agents for prolonging survival of enteric bacteria in shipments of water samples.

Instead of the traditional symposium on history of bacteriology in the local area, the Texas Local Branch compiled and printed a brochure *History of Bacteriology in Texas*, which traces the development of the science from 1902 to date. This brochure was distributed to all members who attended the Houston meeting. Seminars and round-table discussions were held on "Bacterial pigments," "Rickettsial metabolism," "Immunocytochemical staining," and "Teaching of bacteriology to dental students."

The sustaining members together with other commercial exhibitors, presented a group of 35 exhibits, including the newest types of laboratory equipment and apparatus, media and chemicals, glassware, and scientific books. The nine educational and scientific exhibits covered a wide range of interests from microbiology of burns, microbiological safety measures and apparatus, to dental microbiology and the relationships of respiratory flora of surgical personnel and wounds and surgical infections. In the respiratory flora exhibit, bacteriologists attending the meeting were invited to donate a nasal swab culture and participate in this study.

The scientific tours offered to the bacteriologists included a visit to the multi-million dollar Humble Research Laboratory and a trip through the Grand Prize Brewery. A trip through the Imperial Sugar Company's Sugarland Refinery,

where the complete process for manufacture of white, brown, and liquid sugars was on display, was offered. A tour of the Texas Medical Center was arranged. This center consists of more than 160 acres of hospitals, clinics, dental, medical, and postgraduate schools, including the M. D. Anderson Hospital and Tumor Institute, one of four such institutions in the United States.

Of the many papers of outstanding interest, only a few can be mentioned here. A. W. Hofer (New York Agricultural Experimental Station) reported on action of small seed protectants, Spergon, Arasan, and Terrachlor against *Rhizobium*, and A. J. Kluyver (The Netherlands) and W. C. Haynes *et al.* (U.S. Department of Agriculture, Peoria, Ill.) reported a chemical substance derived from *Pseudomonas aureofaciens* capable of inhibiting the growth of a number of plant pathogenic bacteria and fungi. M. A. Williams and S. C. Rittenberg (University of Southern Cal.) reported photographic evidence that certain forms of *Spirillum* found in fresh and salt waters reproduce sexually by joining together during part of their life-cycle. G. E. Mallet and H. Koffler (Purdue University) reported evidence for a molecular basis of thermal stability.

Allan Campbell (University of Michigan) and D. W. McNair Scott and E. DeLamater (University of Pennsylvania) reported working with synchronized cell divisions of growing cultures. Scott and DeLamater were able to show a sequence of synthesis of cell nucleic acid components and speculated that perhaps the effect of various drugs on normal and abnormal cell growth might be localized. S. H. Hutner *et al.* (Haskins Laboratories, New York) reported on the similarity of factors that cause thermal death and radiation damage with implications that measures which counteract thermal injury might also be effective in repairing radiation injury.

J. E. Middlekauff *et al.* (Southern Illinois University) reported the first evidence for gene control to cation sensitivity by showing that sensitivity to lithium is inherited in *Saccharomyces*. Werner Braun *et al.* (Rutgers University) in further studies on the effect of breakdown products of DNA, reported a selective activity for nucleic acid derivatives, and that they can produce changes *in vitro* comparable to those known to occur in susceptible hosts *in vivo*. E. M. Gianforde *et al.* (American Cyanamid Company) reported on the use of enzymatic digestion of tissues as an aid in primary isolation of bacteria and viruses from diseased tissues.

In the field of medical bacteriology and immunology, a number of reports deserve brief mention. C. C. Shepard (U.S. Public Health Service) reported on the

use of HeLa cells infected with tubercle bacilli for the assessment of antitubercular drugs. R. B. Edwards *et al.* reported on the *in vivo* and *in vitro* antibacterial activity of certain hexahydropyrimidines. W. Pelon *et al.* reported the isolation of a cytopathogenic agent from naval recruits suffering from mild respiratory illnesses. Rightsel, Dau, and McLean (Parke, Davis and Company) reported the development of a new polyvalent A.P.C. virus vaccine. G. H. Werner *et al.* (University of Pennsylvania) pinned down the viral etiology of Erythema Infectiosum, and O. C. Liu *et al.* (Sharp and Dohme Company) reported on the activity of caprochlorone on influenza virus infection in de-embryonated eggs and in mice. H. M. Powell and C. G. Culbertson (Eli Lilly and Company) reported on further studies on a new antirabies vaccine prepared from fixed rabies virus grown in duck egg embryos. Murphy, Eylar, Schmidt, and Syverton (University of Minnesota) reported on the survival of polio and other viruses under diverse environmental conditions. The polio virus survived in soil for 12 to 16 days.

J. T. Duff *et al.* (Fort Detrick) reported on studies on *Clostridium botulinum* toxins, the enhancement of toxicity by treatment with trypsin, and purifica-

tion and preparation of botulinum toxoids. Edgar Ribi *et al.* (Rocky Mountain Laboratory USPHS) reported on results of mouse tests of various antigenic fractions of *Salmonella*, indicating that the "endotoxin" fraction may not be identical with the antigen eliciting formation of protective antibodies. Martin, Karlson, and Schatz (National Agricultural College) reported further on the biochemical properties of oral keratinolytic microflora relative to dental caries.

The 19th annual Eli Lilly research award in bacteriology and immunology went to Melvin Cohn, professor of microbiology, Washington University School of Medicine, St. Louis, Mo., for his work on induced enzyme systems. Cohn's achievements have been in studies on normal cell growth, the mechanisms of protein synthesis, studies of bacterial enzyme systems, and characterization and synthesis of antibodies. The award announcement was made at the president's reception, and the address was given at the general session of the society.

The Society of American Bacteriologists will meet in Detroit in 1957, at Purdue University in 1958, in St. Louis in 1959, in Philadelphia in 1960, and in Chicago in 1961.

E. B. M. COOK

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Forthcoming Events

July

22-27. International Cong. of Pediatrics, 8th, Copenhagen, Denmark. (Prof. Franconi, Kinderspital, Steinwiesstrasse 75, Zürich 32, Switzerland.)

22-28. International Cong. of Radiology, 8th, Mexico, D.F., Mexico. (J. Noriega, Tepic 126, 2^o piso, Mexico, D.F.)

23-26. International Cong. of Developmental Biology, 1st, Providence, R.I. (J. W. Wilson, Dept. of Biology, Brown Univ., Providence.)

25-26. Methodology of the Study of Ageing, Ciba Foundation (invitational), London, England. (G. E. W. Wolstenholme, CF, 41 Portland Place, London W.1.)

25-27. Conf. on Solar-Weather Relationships sponsored by American Meteorological Soc., Boulder, Colo. (K. C. Spengler, 3 Joy St., Boston 8, Mass.)

26-28. International Conf. on Biochemical Problems of Lipids, 3rd, Brussels, Belgium. (R. Ruyssen, St. Jansvest 12, Univ. of Ghent, Ghent, Belgium.)

27-28. Linguistic Soc. of America, summer, Ann Arbor, Mich. (A. H. Marckwardt, Dept. of English Language and Literature, Univ. of Michigan, Ann Arbor.)

27-31. Symposium on Cytodifferentiation (invitational), Providence, R.I. (J. W. Wilson, Dept. of Biology, Brown Univ., Providence.)

27-7. International Limnology Cong., 13th, Helsinki, Finland. (H. Luther, Snellmanngatan 16 C 36, Helsinki.)

30-31. Oak Ridge Regional Symposium, 9th, Blacksburg, Va. (Information Dept., Oak Ridge Inst. of Nuclear Studies, P.O. Box 117, Oak Ridge, Tenn.)

30-4. International Physiological Cong., 20th, Brussels, Belgium. (J. J. Reuse, Faculté de Médecine, 115 Boulevard de Waterloo, Brussels.)

August

1-6. International Cong. of Human Genetics, 1st, Copenhagen, Denmark. (Secretary, 1st ICHG, 14, Tagensvej, Copenhagen, N.)

5-10. International Conf. of Social Work, 8th, Munich, Germany. (J. R. Hoffer, 345 E. 46 St., New York 17.)

6-10. Poultry Science Assoc., annual, Raleigh, N.C. (C. B. Ryan, Dept. of Poultry Husbandry, Texas A & M College, College Station.)

6-7. International Mathematical Symposium on Algebraic Topology and Its Applications, Mexico City, Mexico. (Miss J. Silva, Instituto de Matemáticas, Torre de Ciencias, Ciudad Universitaria, México 20, D.F.)

6-8. Soc. of Automotive Engineers, national West Coast meeting, San Francisco, Calif. (Meetings Div., SAE, 29 W. 39 St., New York 18.)

9-18. International Geographical Cong., 18th, Rio de Janeiro, Brazil. (H. O'R. Sternberg, Centro de Pesquisas de Geografia do Brasil, Faculdade Nacional de Filosofia, Av. Presidente Antonio Carlos 40, Rio de Janeiro.)

10-11. Minnesota Acad. of Science, New London, Minn. (B. O. Krogstad, Univ. of Minnesota, Duluth 5B.)

(See issue of 15 June for comprehensive list)



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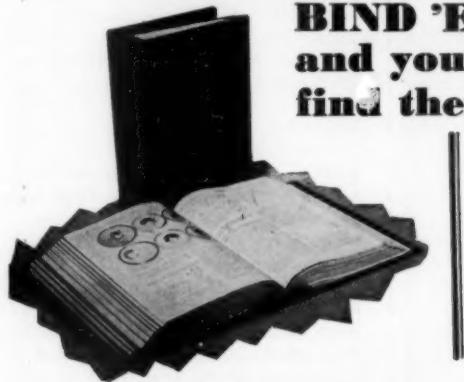


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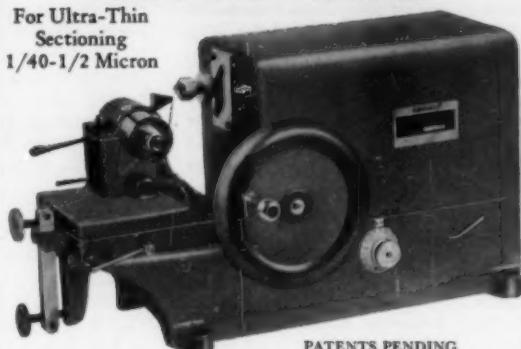
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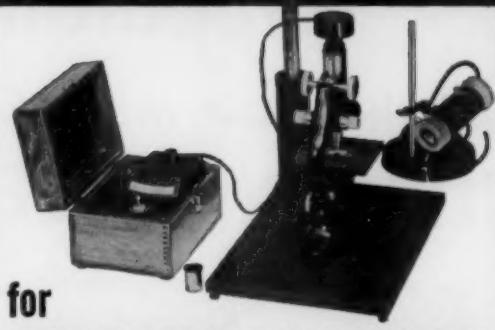
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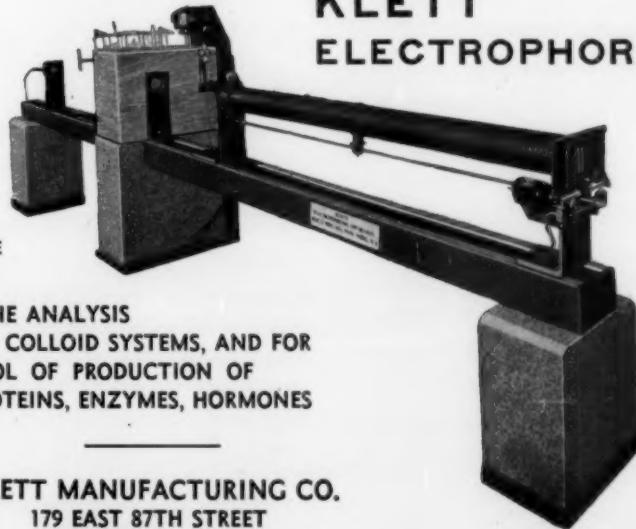
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